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PARKER'S  
JUVENILE  
PHILOSOPHY,  
OR  
INTRODUCTION  
TO THE  
FIRST LESSONS.

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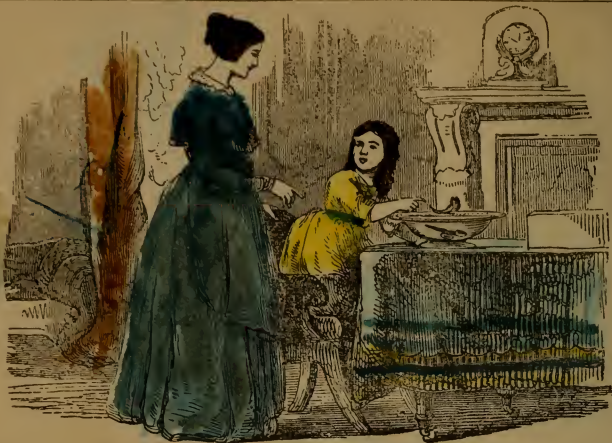


PART FIRST.

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P A R K E R ' S  
JUVENILE PHILOSOPHY.

*Parker*  
*CP*  
*1877*



"I tried to make the feather go down too, but it immediately rose again, just as the cork."

Page 15.



"The heat from her body warms the eggs, and in a few weeks the little chicken comes from the shell."

Page 125.

PARKER'S CONVERSATIONS.

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JUVENILE PHILOSOPHY:  
OR,  
PHILOSOPHY IN FAMILIAR CONVERSATIONS;  
DESIGNED TO  
TEACH YOUNG CHILDREN TO THINK.



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BY RICHARD G. PARKER,

AUTHOR OF THE SCHOOL COMPENDIUM OF NATURAL AND EXPERIMENTAL PHILOSOPHY, &c.

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NEW YORK:  
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Edna C. Spaulding  
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F. C. GUTIERREZ,  
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TO GEORGE C. SHATTUCK, SEN., ESQ., M. D.

DEAR SIR,

This little volume affords me an opportunity of presenting a sincere, though humble tribute of gratitude and respect, to your eminent professional skill, to which, under Providence, I have twice been indebted for restoration to health ; and which has been surpassed only by your active, searching and untiring benevolence.

Very respectfully yours,

RICHARD G. PARKER.

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# JUVENILE PHILOSOPHY.

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## CONVERSATION I.

### ON RAIN.

CHILD. — MOTHER, it is raining fast, and I cannot go and spend the day with Aunt Mary, as you promised that I should. Now I suppose I shall have to stay at home, in the house, all day; and I am tired of my playthings. I want something else to do. Mother

dear, why will you not let me *play school* with you? You be the pupil, and let me ask questions, as they do at the school where brother James goes. If keeping school means only asking hard questions, I think I should make an excellent school-keeper. I have been thinking about a great many things that I see, and I want very much to ask some questions about them. Now, mother *do* you be the pupil, and let me ask you some real hard questions. I know that you can answer them, because I heard father telling you, the other day, about some of them; and father knows all about them, because he reads a great many books, and everybody says that father is a great scholar. Now, I want to know first, *where the rain comes from*. Will you please to tell me?

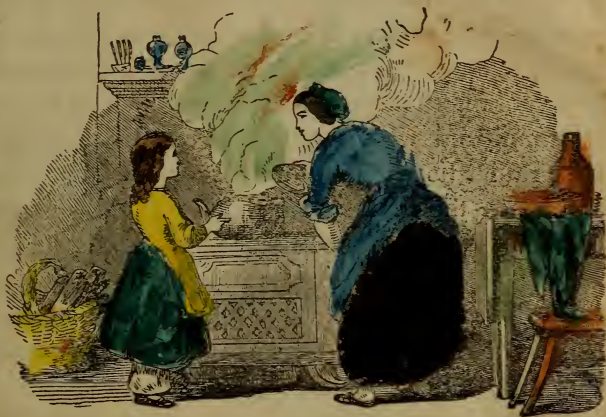
MOTHER.—Rain, my dear, comes from the clouds.

CHILD.—But, mother, how does rain get into the clouds?

MOTHER.—In order that you may understand how the rain gets into the clouds, I must first tell you what a cloud is. And that you may understand what a cloud is, I must first explain to you what is going on in the kitchen. Go out, my dear, and ask Alice the cook to lift up the lid of the tea-kettle, and let you see what is in it.



CHILD.—I have been, mother, and Alice lifted up the lid of the tea-kettle, and all that I could see was a large quantity of smoke that came out of the tea-kettle, and went all over the room; and when Alice put the lid of the kettle on again, some of the same kind of smoke came out of the nose of the kettle, and the lid of the



kettle kept making a chattering noise, and the smoke came from under the lid just as if some one was puffing it out.

MOTHER.—It was not smoke that came from the tea-kettle, my dear. It was *steam*. Now go and ask Alice to take a plate from the china-closet, and hold it over

the tea-kettle a minute, after she has taken off the lid, and then come and tell me what is on the plate.

CHILD.—Oh, mother! Alice has done as you directed, and the plate is covered, all over the bottom, with drops of water. Where did the water come from? She did not put the plate near the water.

MOTHER.—It was not necessary for her to put the plate near the water; the water was formed *on* the plate; and now, if you will listen to me, I will answer both of your questions at once; namely, where the rain comes from, and where the water on the plate came from, or rather how it was formed.

The steam that came from the tea-kettle was made of water. The heat of the fire under the kettle changed the water in the kettle to steam, and when the steam became cold, the steam was changed back again to water. When the steam rose against the cold plate, it became cold, and was changed into water.

Now, you know that there are a great many tea-kettles boiling every morning and evening; and the steam from them goes up the chimneys of the houses, and rises up in the air, and there becomes cold and changes into water; and the water, when it falls down again, makes rain.

CHILD.—But, mother, if rain is made of steam, what

kettle, when Alice lifted the lid; and that steam was nothing more than part of the water, which, being



heated, was changed into steam, and rose out of the tea-kettle and went up the chimney, to assist in forming clouds. When all the water in the kettle has risen out of it, in the form of steam, Alice tells you that it has all *boiled away*. I hope that you now understand what *boiling away* means.

CHILD.—Yes, mother, but there is no fire under the clothes when they are hung out to dry. How, then, can steam come from the clothes when they are put out

of doors to dry, and what has the drying of clothes to do with the forming of clouds and rain?

MOTHER.—The moisture of the clothes changes into steam more slowly than the water in the tea-kettle, but not less surely. It is called *vapor*, as it slowly ascends; and, indeed, it rises so slowly that we cannot see it. But if the damp clothes were brought near to a hot fire, you could easily see the steam or vapor rising from them.

CHILD.—What else, mother, assists in forming clouds and rain, besides the steam from the tea-kettle and the moisture from wet clothes?

MOTHER.—If I were to put a little water into a plate, and set it out in the sun, or in the air, the water would soon be gone. Alice would tell you, perhaps, that it has *dried up*. Now *drying up* means nothing more than that the water has changed into steam or vapor, and has ascended into the sky to help in forming clouds. The same thing takes place when any water or any liquid is exposed to the sun, or the air, or the heat of a fire. The water is constantly changing into steam or vapor, and constantly rising up into the air and forming clouds. Sometimes it rises so slowly that we cannot see it rise, and sometimes very fast, as it did when Alice removed the lid of the tea-kettle.



Now you know, my dear, that there is a great deal of water in some of the ponds and rivers which you have seen when we have been riding out into the country. Besides these, there are other very large bodies of water, called lakes, and seas, and oceans. From all these the water is constantly rising up in the form of steam or vapor, and forming clouds; and when the clouds become sufficiently cold again, they turn back again into water, and fall down in the form of rain.



CHILD.— But, mother, if rain comes from the clouds, where do snow and hail come from ?

MOTHER. — Snow and hail are formed in the same manner with the rain. When the air is very cold, it freezes the clouds, and changes them to snow or hail.

CHILD. — But, mother, if the clouds are changed into water, why do they not all fall down at once, in one body of water, together, instead of falling in drops.

MOTHER. — Because the clouds do not change all at once into water, but gradually. One drop forms at a time, as it did on the plate held over the tea-kettle, and when it is formed it falls. Sometimes it forms in very large drops, and at other times in very small ones; so small that we can scarcely see them. You know that the rain sometimes appears in very large drops, and at other times the drops are so small that we can scarcely see them, — and we call this kind of rain *mist*. As the drops fall also, sometimes two, three or more drops, will be driven together by the wind, or some other cause, and thus form a large drop.

CHILD. — Well, mother, I think I know now where rain comes from, but I do not understand why it falls. Steam, you say, *goes up*, and rain *comes down*. Why do not both *go up*, or both *come down*? What makes them go different ways?

MOTHER. — You have asked me a question, I fear, my dear, that will be more easy for me to answer than for

you to understand. But I will try to make it easy for you to understand. There is a basin of water on the table. Take this gold coin and put it into the basin, and tell me where it goes to.

CHILD.—It has gone down to the bottom of the basin, mother.

MOTHER.—Now take the cork from that bottle, and put that into the basin.



CHILD.—I have done so, mother, but the cork remains on the top of the water.

MOTHER.—Take the cork in your hand, my dear,

and put it down to the bottom of the basin, at the side of the gold coin.

CHILD.—It will not stay there, mother; as soon as I remove my hand, it rises right up to the top of the water.

MOTHER.—Take my scissors, and this needle, and also this feather, and put them into the basin.

CHILD.—The scissors and the needle, mother, have fallen down to the bottom of the water, and the feather remains at the top. I tried to make the feather go down too, but it immediately rose again, just as the cork.

MOTHER.—You see, then, that in water some things will fall and others will rise. It is just so in the air. Some things rise and others fall in the air. Thus smoke and steam and vapor rise, while water, and a great many other things, as you know, will fall. Things which are lighter than water will rise when they are put down into the water, and those things which are heavier than water will fall or sink when put into the water. So it is in the air. Those things which are lighter than air will rise in the air, while those things which are heavier than air will fall. When you are a little older, and are able to understand it, I will explain this subject more fully to you. In the mean time, I will only add, that water is one of the most interesting subjects of contemplation that our great



and good Creator has spread before us. It is constantly changing, — constantly rising in the form of steam or vapor, and as constantly the steam and vapor is changed again to water, and falls down in the form of rain, snow and hail. This change has been going on ever since the creation ; so that, notwithstanding all the water which has been used for the various purposes for which it is employed, there is now just as much water existing, either in the form of steam, vapor, or in its proper and common form, as there was when God first created the world.

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#### QUESTIONS TO CONVERSATION FIRST.

Where does rain come from? <sup>+</sup>

What comes from a tea-kettle when water is boiling in it ?

What is steam made of?

How can steam be re-changed into water?

Where does steam go when it rises?

Where does water go when it boils away?

What is vapor?

What do we mean when we say "*water dries up*"?

What is snow?

What is hail?

What is mist?

Why does steam rise?

Why does rain fall?

Why does cork float in water?

Why will some things float and others sink in water?

What things will rise in water?

What things will sink in water?

What things will rise in the air?

What things will fall in the air?

What changes is water constantly undergoing?

Is there more or less water now than when God first created the world?

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## CONVERSATION II.

## COLOR.

CHILD.—MOTHER, you told me, when we were talking about rain, that you would tell me why the clouds are not always of the same color. Now, you must be my pupil again, as you were then, and answer that hard question.

MOTHER.—Yes, my dear, I will; but before I tell you, I must do as I did when we were talking about the clouds. I must make you answer me some ques-

tions too, so that you may be made to think yourself; for you can always recollect best what is told you, when you are made to think about it first. Now, before I tell you why the clouds are not always of the same color, I must ask you about that pretty blue frock which you have on. When you go to bed at night, it is hung on the chair by the side of your bed. When the light is removed from your chamber, what color does your frock then appear to be?

CHILD.—Why, mother, I cannot see it at all — nobody can see anything in the dark.

MOTHER.—You are mistaken, my child. It is true that neither you nor I can see it; but puss can see it almost as well in the dark as she can in the daytime. Cats, and some other animals, are gifted with this remarkable faculty.

CHILD.—Why, mother, can cats see in the dark? I should think that would be impossible. How can they do it?

MOTHER.—I will explain that to you, my dear, after I have done with the color of the clouds, which you first asked about. All good teachers are contented to wait for the answers to their first questions, before they expect answers to others. Now, if I am to be your pupil, you must let me answer one question at a time, and

when I have given you a satisfactory answer, then I will listen to any other that you may propose. You told me that you could not see your blue frock, nor anything else, in the dark. But the frock is there, notwithstanding that you cannot see it, and so also are the chairs, and the tables, and the glasses, and the pictures, although you cannot see them. If the light be brought back into the room, you can then see them all in their proper places, which shows you that they do not go out with the light.

CHILD. — Yes, mother, I know that they have not been removed, but that I cannot see them without a light.

MOTHER. — As soon as the light is brought back, you can see the color of them too. But could you not, in the dark, tell whether the things are in the room?

CHILD. — Yes, mother, I could feel them, by groping about the room in the dark.

MOTHER. — And when you feel them, can you feel the color too?

CHILD. — No, mother, I could not feel the color.

MOTHER. — If there were two things of the same kind, — such, for instance, as a blue and a red ribbon, — could you tell, in the dark, which is the red and which is the blue one?

CHILD. — No, mother, I am sure I could not.



MOTHER. — But you could distinguish a sheet from a blanket, on the bed, in the dark, could you not ?

CHILD. — Yes, mother, because they feel very differently. The sheet is made of linen, and feels soft and smooth; but the blanket is made of wool, and feels rough and hairy.

MOTHER. — The color, then, cannot be known until the light is brought, and then it reappears. Now, if the color comes with the light, and disappears when the light is removed, what must color depend on ?

CHILD. — Why, mother, color must depend on the light, does it not ?

MOTHER. — Yes, my child, color depends wholly on the light; and where there is no light, there can be no color.

CHILD. — But, mother, if color depends on the light, why is not everything of the same color ? How can light paint everything so beautifully — some things blue, some red, and other beautiful colors. I should think that everything would appear *light* color, if I thought that light had any color.

MOTHER. — That is the very thing I propose to explain to you, my dear. Here is a thick piece of glass, with three sides. It looks just like those drops hanging from the lamps over the fire-place, only the sides are

all alike, and, for that reason, it is called a prism. Take it into your hand, Caroline, and hold it up to the light, and tell me what you see.

CHILD.—I cannot see anything through it, mother, only it looks light.

MOTHER.—Turn it a little, very slowly, while you hold it up to your eye.



CHILD.—Oh, mother, how many beautiful colors there are in it, as I turn it round! There are red, and blue, and yellow, and other beautiful colors in it.

MOTHER.—Yes, my dear; and now take this thick glass, which you see contains nothing but water, and tell me whether you can see any colors in it, when you hold it up to the light.

CHILD. — Yes, mother, I see the same colors again, in the glass of water.



MOTHER. — Well, Caroline, I suppose you know that the colors are neither in the glass nor in the water; for, if they were, you could see them without holding the glass up to the light.

CHILD. — Yes, mother, I see that the colors are neither in the glass nor in the water, and they appear only as the glass is held up to the light. Now, mother, I shall have to ask you that other hard question, which you spoke of when we were talking about the rain. I must ask you *what light is*, which paints everything so beautifully?



MOTHER.— You must not forget, my dear, that I have not yet answered your former question, why the clouds do not always appear of the same color. I shall give you a satisfactory answer to that question presently. But I must first explain to you something about light and color.

It has pleased our great and good Creator to permit us to find out some of his works; but not all. Thus I have told you what rain is, and where it comes from. But nobody knows what light is, except the great Creator himself. All that I can say, in answer to your question, is, that we know a great many things about light, but *we do not know what light is*. Thus we know that it appears to move very fast, and always to go in straight lines, without turning in any direction, of itself. We know that it will go directly through some things, while there are other things which it goes through with great difficulty, and others that it cannot pass through at all. You can see through the panes of glass in the window into the street, but, if you cover the glass in the window with paper, you cannot see distinctly through the paper, and, if a board were placed before the window, you could not see through it at all.

CHILD.— Well, mother, if you cannot tell me what

light is, can you *tell me what color is*, that light brings with it?

MOTHER.—Yes, my child, and I can tell you many more things about light also. When you held the glass up to the light, you saw many beautiful colors, which you know were not in the glass, but must have been in the light. You recollect, I suppose, telling me, a few minutes ago, that you should suppose that everything would appear *light color*, if you thought that light had any color. Now I must tell you that light *has* not one color, but several, and all the colors which you saw in the glass were nothing but the *colors of light*.

CHILD.—Colors of light, mother? If light has colors, why do we not always see them?

MOTHER.—We do, my dear, but not always all together, nor all on the same thing. Light is made of colors, so skilfully and beautifully mixed up together by the great God of heaven, that we do not see them separately, except on different objects. You have seen Alice the cook make cake, and are fond of eating it when she has made it. You know that it is made of flour, and sugar, and eggs, and butter, and many other good things. When they are all mixed together and baked, you cannot see the sugar, nor the butter, nor the flour, nor the eggs, nor the other good things. And when you eat the cake,

you do not taste any one of them in particular. It is the combination, that is, the mixing together, of the flavor of each, which produces that pleasant taste which children love so much in cake. You have also seen me squeeze a lemon, which you know is very sour, into a pitcher, with some water and sugar, thus producing a very pleasant drink, called lemonade.

Now, when you drink the lemonade, you do not taste the lemon alone, nor the sugar alone, nor the water alone, but you taste them all together. Their flavors are united, and produce that very agreeable drink, of which almost every one is so fond. So it is with light. The colors are so beautifully mixed together that we do not see any one of them, but all together.

CHILD. — But, mother, if, as you say, we cannot see the colors in light, how do we know that light is composed of colors? You told me that nobody knows what light is, except the great God that made it.

MOTHER. — It is true, my child, nobody knows what light is, but I told you that I could tell you many things about it. Now listen to what I say. Light, as I told you, moves very fast, and always goes in a straight line from the place from which it comes; but, when it passes from the air through glass or through water, or from any one substance to another, it is always turned out

of its course, and goes in a straight line in a little different direction. And it has been found that some of the colors of which light is composed, in going from one substance into another, are turned out of their course more than others, and they thus become separated, and we can see them each separately and distinctly. When you looked through the prism, or three-sided glass, which I showed you, you saw them separated.

CHILD. — Well, mother, why could I not see the separate colors in the room, if the glass caused them to separate ?

MOTHER. — Because, my dear, the light which came into the room from the windows was all around it, and you saw other light besides that which came through the prism. If I had shut the shutters in the room, and made the room dark, and let the light into the room only through a small aperture in one of the shutters, and then put the prism up to the aperture, letting no light come into the room ~~except~~ that which came through the prism, you would then have seen the colors of light all separated. You would have seen on the wall a beautiful bright place, part *red*, part *orange*, part *yellow*, part *green*, part *blue*, part *indigo*, and part *violet*.

CHILD. — Dear mother, how wonderful ! But I do not understand why some things, when the light shines



upon them, appear red, and others blue, and others of different colors. Can you explain that to me?

MOTHER. — Yes, my dear, I can, but you must assist me in explaining it. Take your little ball, and throw it against the door, and tell me what it does, after it strikes against the door.

CHILD. — Why, mother, I have done so, and the ball comes right back again towards me.

MOTHER. — That is very true, Caroline. Now, my child, take a tea-spoonful of water, and throw it against my handkerchief, as I hold it spread out before you, and tell me whether the water will come back to you, like the ball which you threw against the door.

CHILD. — No, mother, the water does not come back; it remains in the handkerchief.

MOTHER. — That is precisely the manner in which the colors of light are affected. Some of the colors of the light which shines on objects come back to our eyes, as the ball did from the door, and others remain in the object, as the water did in the handkerchief. And the things which we are looking at always appear of that color which *comes back*, or, as philosophers call it, *are reflected*. Those colors which do not *come back* are said to be *absorbed*.

CHILD. — What a glorious thing light must be, mother,

that produces such wonderful effects ! But you told me that there were only seven different colors in light. You said they were *red, orange, yellow, green, blue, indigo, and violet* ; but there are a great many other colors, besides these. There is gray, and olive, and purple, and scarlet, and crimson, and a great many other colors, and particularly black and white. You did not mention any of these. Now, mother, there are a great many things which are black, and a great many which are white, like the beautiful snow.

MOTHER. — No, my dear, I did not mention them, and I will now tell you the reason. You know that Alice sometimes makes cake of different kinds. Sometimes she puts eggs and butter into the cake, and sometimes she does not ; and the cake tastes of all the materials united, which she puts into it. Now, as I told you, light is composed of all the colors which I mentioned to you. But it *comes back, or is reflected*, from the objects on which it falls, in a great many different ways. Sometimes only one of the colors is reflected, — as blue, for instance, — and then the objects appear to be blue ; and sometimes the red and the blue are both reflected, and then the objects appear of a purple color, which is a mixture of red and blue. All colors are thus produced by a mixture of several of these seven colors ; but some-

times none of the colors are reflected, but they are all absorbed. Can you tell me, Caroline, how an object would look that reflects none of the colors?

CHILD.—Why, mother, if none of the colors are reflected, we could not see it at all.

MOTHER.—You are not right, my child; we could see it, although it has no color.

CHILD.—Why, mother, how can that be? Everything that we see is of some color or other, or of several colors mixed together.

MOTHER.—There again you are wrong. We can see many things that have no color; but then those things must look just as your blue frock would look in the dark. Now if you recollect what I said about the dark, you perhaps can tell me what color the blue frock is of, in the dark.

CHILD.—Why, mother, it would look all dark and black.

MOTHER.—Precisely so; and that is the way that all things appear from which no light is reflected. All the colors are *absorbed*; and, of course, the objects that reflect no colors can have none, and must appear as they would if it were in the dark.

CHILD.—Why, mother, is not black a color?

MOTHER.—No, it is merely the absence of all color, in

the same manner as darkness is merely the absence of light.

CHILD.—How wonderful! I always thought that black is a color.

MOTHER.—That is a very common mistake, but it is no less a mistake because it is common.

CHILD.—But, mother, if black is not a color, white certainly must be one, is it not?

MOTHER.—No, white is not *one* color, any more than cake is all one thing. Cake, you know, is not all flour, nor all sugar, nor all butter, nor all eggs, but it is a mixture of them all; and the nicer the articles of which the cake is made, the nicer, you know, the cake itself will be. *White* also is not *a color*, but it is the mixture of all the seven colors which you saw in the prism; and the nicer the colors are, the purer and brighter will be the white which they produce.

You know that the wheels of a carriage sometimes go round so fast that you cannot distinctly see the spokes or sticks which form the wheel. Now, if we take a round piece of board or a card, and paint the seven colors on it in a certain way, like the spokes of a wheel, and, sticking a pin through the middle of it, we make it go round fast on the pin, just as the wheel of a carriage would go round if it were lifted from the



ground, and made to turn fast, you could not see the different colors which are painted on the card, any more than you can see the separate spokes of the wheel. As the wheel turns round, all the spokes seem to run together, and the wheel appears as if it were full of spokes. So it will be with the colors painted on the card. We could not see any one of them, but they would appear to be mixed together, and look white.

CHILD. — But, mother, light does not look white, like snow.

MOTHER. — No, Caroline, it does not. And when the snow is melted, and becomes water, it does not then look white, like snow, but it looks just like the light when we look at it as it enters the window. The purer the colors are of which white is made, the purer the white itself will be. The snow is water, or rather vapor, frozen; and, although you can see through ice, yet you can see more distinctly through the water of which ice is made, when it is melted. In other words, the colors are all reflected, but not perfectly, by the snow, and that is the reason that the snow looks white; but, when the colors are all perfectly reflected, the whiteness is of a purer kind, like light itself. So it will be in the painted card. The whiteness produced by the colors when the card is turned will not be a pure white, like light, nor even so

pure as the snow, and the reason is, that man cannot produce colors so pure as those which exist in light. Nothing which man makes is so pure or so perfect as that which God makes.

CHILD. — Well, mother, you told me that the clouds are composed of steam, or vapor. If they are all made of the same thing, why are they not all of the same color ?

MOTHER. — Now, Caroline, I shall be able to answer this question, which, if you recollect, is the same that you began with in this conversation. I told you that light passes easily through some things, and with more difficulty through others. The clouds are composed of steam, or vapor, as I told you. But they are constantly changing. Sometimes they are very thin, and a small quantity of vapor *swells out*, and fills a great space ; at other times, a large quantity of the vapor is pressed together, and becomes very thick. Now, if I were to make two pin-cushions of the same size, but stuff the one with more wool than the other, it will be more difficult to stick a pin into the one which is stuffed with the greater quantity of wool. So it is with the light which shines on a cloud. When they are thin, the light passes through them easily, and they appear white, or nearly so ; and, when they are very thick, the light passes through

them with great difficulty, and they appear of darker tints. Just before they are converted into water, they become thick, so that no light, or but very little light, can pass through them; they then appear very dark.

CHILD.—Oh yes, mother, and that is the reason that, when we see a great black cloud in the sky, you always say that it is going to rain.

MOTHER.—Yes, my dear, I say that I expect it will rain; but I do not always know that it will, because the wind may blow the cloud away from over our heads, and then it will fall in rain at some other place, perhaps at a great distance from us.

CHILD.—I now understand, dear mother, why the clouds appear of so many beautiful colors. But when there are no clouds, the sky always appears of a beautiful blue. Can you tell me the reason of that?

MOTHER.—Yes, my child; you know that I told you, when you were looking at the prism, that some of the colors of light are more easily turned out of their course than others, when they pass from one substance into another.

CHILD.—Yes, mother, and I believe that the red rays, the orange and the yellow, were turned the least, and the violet, the indigo, and the blue, the most of all.

MOTHER.—Well, my dear! Now if you take a feather

in one hand, and a ball in the other, and throw them both at once from your hand, which could be more easily stopped, the ball or the feather?

CHILD.—Why, mother, the feather, to be sure. But what has that to do with the color of the sky?

MOTHER.—Nothing, my dear, except to explain one thing by its resemblance to another. Now the blue rays of light, like the feather, are very easily stopped. They cannot pass wholly through the air, while all the other colors readily pass through it, and we see only the blue ones which are passing through the atmosphere. When a bullet is fired from a gun, it goes so fast that we cannot see it; but, if a stone is thrown by the hand, we can see it all the time that it is moving.

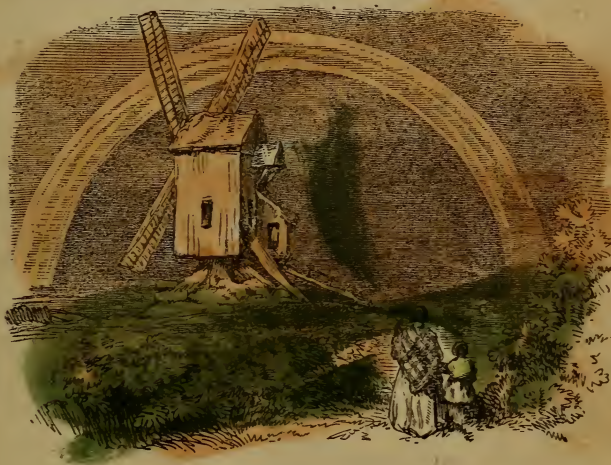
CHILD.—I understand it now, dear mother. And now can you tell me why the sun sometimes looks red, like a ball of fire?

MOTHER.—Yes, child; the red rays go with so much force that they can pass through mist and vapors so thick that the other rays cannot penetrate them. When the air is filled with vapors, the red rays of the sun come through the vapors, and we see them when we cannot see the other colors which exist in the bright beams of the glorious sun.

And now, my dear, there is another singular and



very beautiful thing which we sometimes see in the sky, but never, excepting when the sun shines on one side of the heavens, while there is rain falling from a cloud on the other. That is the rainbow. It is caused by the sunshine, or the light from the sun. As it attempts to pass through the rain and the clouds, the colors of light become separated, and we see all the beautiful colors which you saw in the prism.



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#### QUESTIONS TO CONVERSATION SECOND.

Of what color is everything in the dark ?

Can any one see in the dark ?

What animals can see in the dark ?



Can you distinguish colors in the dark?

Can you distinguish anything in the dark?

What does color depend on?

Can there be any color where there is no light?

What is a prism?

What is light?

In what direction does light always move?

Can light pass through solid substances?

Where do colors come from?

If colors come from light, why do we not always see them all together?

When light passes from one substance into another, what effect is produced?

What colors are found in light?

What is meant by light being reflected?

What is meant by light being absorbed?

How do those bodies appear which reflect all the light that falls on them?

How do those bodies appear which absorb all the light that falls on them?

How are all colors produced?

Can we see things that have no color?

Is *black* a color?

If black is not a color, what is it?

Is white a color?

If white is not a color, what is it?

What is the reason that snow looks white?

Why are not the clouds always of the same color?

Why does the sky appear blue?

Why does the sun sometimes look red?

## CONVERSATION III.

## VISION, OR SIGHT.

CHILD.—MOTHER, you told me that cats and some other animals can see in the dark almost as well as they can in the light, and you promised to explain the reason to me. Now please to tell me, mother.

MOTHER.—I will try, my dear, to make it plain to you; but first shut your eyes, and tell me what you see.

CHILD.—Why, mother, I cannot see at all, when I shut my eyes; nobody can.

MOTHER.—Well, my dear, you know, then, that to see at all, it is necessary to have eyes; and, therefore, if there is any difference in the faculty of seeing, in different animals, the difference must be in the manner in which their eyes are constructed.

CHILD.—I suppose it must be so, mother, because you say so. But cats sometimes shut their eyes; can they then see, when their eyes are shut?

MOTHER.—No, Caroline; no animal can see when its eyes are shut. But before I explain to you the difference in the eyes of cats, I must explain to you some-

thing about your own. Now look directly at my eyes, as I am looking at you, and tell me what colors you see in my eyes.

CHILD.—All around the edges, dear mother, your eyes look white; but then there is a round part, within the edges, which is blue; but directly in the middle there is a little round place, which looks very black.

MOTHER.—It is that little round place in the middle of the eye, which you say looks so black, that I wish you to notice particularly, my dear. It is called the *pupil of the eye*. Now, Caroline, let us go into the darkest corner of the room, and then do you look at that little spot in my eyes, and tell me whether you can see any alteration in it.

CHILD.—No, mother, I do not see that it has altered much, only it looks a little larger.

MOTHER.—Now let us go together to that part of the room where the sun is shining, and then do you tell me whether you can see any difference.

CHILD.—Why, mother, it is a great deal smaller now.

MOTHER.—Yes, my dear; and now take puss the cat, and look at her eyes in the same ways that you did at mine, and tell me what difference you see.

CHILD.—Why, mother, when I looked at pussy's eyes in the dark corner of the room, that little black

part in the middle, which you called the pupil, was quite large; and when I brought her into the sunshine, it almost closed up, and looked very narrow.

MOTHER.—Did you observe no difference also in the shape of the pupil in the cat's eyes and in mine?

CHILD.—Yes, mother; in your eyes it is round, and in the cat's it is not round, but shaped more like an egg,—longer than it is wide.

MOTHER.—You have now described to me the difference in the eyes of cats, and other animals that can see in the dark, and our eyes. You have noticed that the pupil of the eye, both in a cat and in a human being, becomes larger in a dark place, and smaller in a light one. I must now tell you that we can see only by that light which passes through the pupil to the inside of the eye, and that the pupil itself is nothing more than an opening in the eye, to admit the light to pass to the inside of the eye, and enable us to see. You know that some people have blue eyes, like mine, others have black ones, and some hazel, and other colors. The color of the eye depends on the colors of the light which are reflected from this part of the eye, called *the iris*. But the light which enters the pupil passes to the inside of the eye, and the pupil always appears black, because no light is reflected from it. Now, the larger

the pupil is, the greater will be the quantity of light which enters into the eye. As the pupil of the eyes of cats becomes much larger in dark places than the pupil of our eyes, those animals can see more readily than we can, where there is very little light.

CHILD.—What is the reason, mother, that when I go into a dark place, it at first appears very dark, and I cannot see anything at all; but after I have been there a short time, I begin to see things, at first indistinctly, and afterwards more clearly?

MOTHER.—The reason, my dear, is, that while you are in a light room the pupil of your eye is small, or rather open but little; and when you go into a dark place, but little light can go through the pupil into the eye. But while you continue in the dark place, the pupil gradually grows larger, or rather opens wider, and thus admitting more light, you begin to see better.

CHILD.—And when I come from a dark place into the sunshine, or into a very light room, I cannot see so well as I did in the dark place. What is the reason of that, mother?

MOTHER.—The eye, my child, is a very delicate and tender thing, and is easily affected. You know that you cannot look directly at the sun, when it is shining brightly, because, as you say, it *dazzles* your eye.



Now, when you have been in a dark place for some time, the pupil of your eye has grown larger, to admit more light, to enable you to see. When you come into the sunshine, or into a light room, with the pupil thus enlarged, the light in the room dazzles your eye, until the pupil has had time to grow smaller, so as to prevent so much light from passing into the eye.

CHILD.—What is the reason, mother, that grandfather, and a great many other old people, put on spectacles when they read, or wish to see anything near to them ?



MOTHER.—The eye, my dear, in order to see well, must be of a particular shape, and all its parts must be formed in a particular manner. The eye itself is gener-

ally perfectly round; but it is often the case, as people grow old, their eyes lose a little of their roundness, and become more flat. It is then necessary for them to wear glasses, in order to make the light pass to the proper place inside of the eye, to enable them to see.

CHILD.—But, mother, there is Cousin George, he is not old; he is not yet a man; and yet he wears spectacles. Are his eyes too flat to see well?

MOTHER.—No, Caroline, quite the contrary; his eyes are not too flat, — they are too round.

CHILD.—Why, mother, will spectacles assist the sight of both those whose eyes are too flat and those also whose eyes are too round?

MOTHER.—Yes, my dear, they will; but the glasses in the spectacles must be of different shape for those whose eyes are too round. Did you ever examine your Cousin George's spectacles, to see whether the glasses are like those in your grandfather's?

CHILD.—No, mother; I always supposed they were alike, except that grandfather's spectacles are gold, and Cousin George's are steel.

MOTHER.—Well, Caroline, your Cousin George could not see with your grandfather's spectacles, nor could your grandfather see with Cousin George's. If you were to examine the glasses in each, you would see

that they are no more alike than the inside and the outside of a cup or a saucer ; and if you were to break one of the glasses into halves, you would see that your grandfather's are thickest in the middle and thinnest at the edges, while the glasses in your Cousin George's are thickest at the edges and thinnest in the middle.



CHILD. — But, mother, I have seen grandfather sometimes, when he had not his spectacles with him, holding a paper he wanted to read at a great distance from his eyes, while Cousin George, when he reads without his spectacles, holds his book so close to his eyes that he almost touches them with his book. What is the reason of this, mother ?

MOTHER.—The reason is, my child, that when the eyes lose their natural roundness and become more flat, they can see things best when they are held far off from the eye. This is called being *far-sighted*. But when the eyes are too round, they cannot see things at a distance, but the thing to be seen must be brought near to the eye. This is called being *short-sighted*, or near-sighted. It is the eyes of old persons, generally, that are too flat; it is very rarely the case that the eyes of old people are too round.

CHILD.—Why, mother, a short time ago, there was a little girl who could not see very well without holding her book so close to her eyes as almost to touch them. The teacher told her that she would better request her parents to procure a pair of spectacles for her. Accordingly, she came to school, the next day, with her grandmother's spectacles on; and she said that she could see much better with them than without them.\*

MOTHER.—If she said so, my dear, she either deceived herself, or said what was not true. She could, in fact, see no better with her grandmother's spectacles than you can with your grandfather's, nor, indeed, so well. But I suppose she wanted to wear the spec-

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\* This fact actually occurred, in the school of which the author had the charge, a few years ago.



tacles for the same reason that foolish boys sometimes wish to smoke cigars, — not that it is any benefit to them, nor that they derive any pleasure from it; but they very unwisely think it makes them appear like men. Children are very fond of imitating those who are older than themselves, and they are too apt to imitate either their faults or their infirmities, instead of their virtues and their good example.

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### QUESTIONS TO CONVERSATION THIRD.

Can any animals see in the dark?

What can you see when you shut your eyes?

What is it necessary to have, in order to be able to see?

Why can some persons see better than others?

When you look at a person's eyes, what can you see?

What is the *pupil* of the eye?

How does an increase of light affect the pupil?

How does the decrease of light affect the pupil?

Does the pupil of the eye of a cat alter in size in the sunshine?

What difference is there in the shape of the pupil, in the eyes of a cat, and in those of a man or woman?

Why can a cat see in the dark?

Why are the eyes of different persons of different color?

On what does the color of the eye depend?

Why do all things appear dark when you first go into a dark room?

How can you afterwards see things distinctly in the same room?



Why can you not see well when you first come from a dark place into a bright room ?

Why do old people generally wear spectacles ?

Why do young persons sometimes wear spectacles ?

What is the difference between the spectacles which old people generally wear and those which young people sometimes wear ?


Can old persons see with the spectacles made for young persons, or young persons see with spectacles made for old ones ?

In what part are the glasses in the spectacles of old persons the thickest ? and in what part are glasses in the spectacles of young persons the thickest ?

How do old persons hold their book or paper, when they read without their glasses ?

What is meant by *being far-sighted* ?

What is meant by being *short-sighted* ?



## CONVERSATION IV.

## THE EYE.

CHILD. — MOTHER dear, you told me so many interesting things about rain, and the clouds, and the light, and the beautiful colors, that I am sure I shall never be tired of thinking about them. You also told me all about grandfather's spectacles, and Cousin George's, and about people having eyes too round or too flat, and I believe I shall be looking at everybody's eye, to see whether their eyes are round or flattened.

MOTHER. — That would be a very useless task, my dear, because you could not tell, by looking at them, whether they were too round or too flat. Everybody's eyes look round alike; but the eye is a very beautiful piece of mechanism, consisting of no fewer than ten different parts, each of which has a different name. You are too young to understand all these hard names now, and therefore it will be useless for me to mention them to you. But I will tell you that some of these parts are shaped very much like the glass in your grandfather's spectacles; and it is these parts, in the inside of the eye, that become too round or too flat, and not the

whole eye. You cannot see these parts in anybody's eye; but there is no eye without them. There is another thing, however, about the eye, which you should observe, in order that you may see how wonderfully our great and good Creator has protected the eye, the most delicate and sensitive part of our frame. You know how much pain it gives you when a little dust or water, or any little mote, gets into your eye. Now, look at my eyes, and tell me what there is above them.

CHILD.—Why, mother, I do not see anything above your eyes, except those long hairs, which you have told me are called *eye-lashes*; and above them, another small portion of hair, which, I believe, you called the *eye-brows*. Then, above your eye-brows, there is your forehead, and then your long, beautiful hair. Have these anything to do with the eyes, or with seeing?

MOTHER.—They have not, my dear, anything to do with seeing; but the eye-lids and eye-brows are designed to protect the eyes. Now, when the hair is wet, the water will run down, you know, all over the face; can you tell me what prevents its running into the eyes?

CHILD.—Oh yes, I see now, mother; the eye-brows make it turn and run down by the side of the eye, instead of running directly into it. But what is the use

of the eye-lashes, mother? The eye-brows alone prevent the water running into the eye.

MOTHER. — Yes, my dear; but when Alice is taking up the ashes from the grate, or is sweeping the room, the fine dust and ashes, you know, will rise all over the room, and afterwards fall down again, covering everything in the room with fine dust. Now, can you tell me what prevents the dust, as it falls, from falling directly into her eyes?

CHILD. — Oh yes, dear mother; I see now that the eye-lashes will prevent the dust from entering into her eyes, in the same manner that the gauze over the picture-frames prevents the dust from injuring them.



MOTHER. — But that is not all, my child. When you walk out into the bright sunshine, the eye-lashes, being spread out over and before the eye, partly cover them, and protect them from being dazzled by the bright sunshine. Sometimes the eye-lashes are not sufficient,

when looking at a bright object, and then we put up our hand over the eye, to protect it more.

Many years ago, a nation called the Carthaginians took a Roman general prisoner, whose name was Regulus. He was a very good man, but the Carthaginians did not like him, because he had done their nation much harm. When they took him prisoner, they treated him very cruelly, and, among other things which they did, they put him into a dark dungeon and cut off his eyebrows and eye-lashes, and then carried him out and exposed him to the bright sunshine, with his hands tied behind him. Now, do you know how this would affect him?

CHILD.—Oh yes, mother, his eyes would be dazzled by the bright sunshine, and all the dust floating in the air would get into his eyes, and pain him very much.

MOTHER.—Yes, my dear, and he, undoubtedly, suffered very much from this act of cruelty. But I have not told you yet all that God has done to protect your eyes. You know that you can shut your eyes when you please, and open them when you please. You know, also, that when you go to sleep, you always shut your eyes. Now, could you not sleep with your eyes open?

CHILD.—Why, no, mother; everybody shuts the eyes



when going to sleep. Even puss, and the dog, and every other animal.

MOTHER.—Yes, Caroline, but when you go to sleep, do you know at what particular moment of time your eyes close?

CHILD.—No, mother; how can I tell? Can anybody?

MOTHER.—No, my dear, no one can tell. The eyes close of themselves, without our shutting them; nor are we conscious of their shutting. But why do you suppose that the eyes close when we go to sleep?

CHILD.—Why, mother, who could sleep with his eyes open?

MOTHER.—A great many people get up when they are asleep, and walk about with their eyes open, without waking up. They are called somnambulists, because they walk in their sleep. But do not your eyes open and shut of themselves, very often, when you are wide awake, without your thinking at all about it?

CHILD.—Why, no, mother; how can my eyes open and shut without my knowing anything about it?

MOTHER.—They do, my child, very often. Look at my eyes, and see whether I can keep them open long without their moving.

CHILD.—Why, mother, you only *winked* while I looked at you.

MOTHER.—And what is *winking*, but opening and shutting your eyes? Now, if a person hold up anything suddenly to the face of another person, that person immediately opens and shuts his eyes; that is, he *winks*: and he does this without intending to do it, or even knowing that he has done so. And this is a faculty with which our great Creator has endowed us, for the purpose of protecting the eye, by closing it, that is, covering it with a thick covering, called *the eye-lid*. And now, as you did not answer the question I just asked,—why the eyes close when we go to sleep,—I must tell you that was caused by our good Creator, to prevent anything from getting into our eyes, to injure them, while we sleep, and are unable to protect them by covering them with our hands.

CHILD.—But, mother, why did he make us wink so often? I have been watching your eyes, and I saw you wink a great many times. And, now that I think of it, I find that I am winking almost all the time, and I cannot help it.

MOTHER.—Did you ever see your grandfather, or your Cousin George, wipe their spectacles, before they put them on?

CHILD.—Oh yes, mother, they wipe them very often; and Cousin George is very particular to wipe his with a

very nice piece of soft leather, which he carries in his pocket.



MOTHER.—Well, Caroline, you know that they wipe the glasses of their spectacles to get off the fine dust which is constantly floating about in the air, and other things also, which sometimes get on the glasses, and which, if suffered to remain, would prevent their seeing well through the glasses.

CHILD.—Oh yes, mother; but what has that to do with winking?

MOTHER.—I am about to tell you, my child. You recollect that I told you that the eye is very delicate,

and that it is shaped in the inside like the glasses of spectacles. Now, the fine dust and other things that are in the air will always be getting in the eyes, and the eyes are constantly wiping themselves, to rid themselves of the smallest particle that may get on them.

CHILD. — The eyes wiping themselves, mother! How can that be, mother?

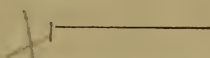
MOTHER. — Why, my dear, *wiping* anything is nothing more than causing some soft substance to pass over it; and when we wink, the eye-lid, which is much softer than the softest leather or the finest silk, merely passes over the eye, and wipes off anything which may have rested on it, and then immediately passes back again, and leaves the eye open. There is another use in winking, which you will not be able to understand at present, and which I must omit until you are a little older. But I have told you enough to show you the wisdom of God, in providing so many ways to protect this delicate member from harm. He has placed beautiful eye-brows and eye-lashes over it, and given it the faculty of shutting itself, to protect itself from harm while asleep, or when anything suddenly approaches it.

CHILD. — O, dear mother, how wise and good must that great God be, whom we worship daily. I see a great many beautiful things around me, which you



have told me God has made; but now I begin to see that there are many things about my own body, which show me how kind and gracious he is to me, and how much he has done for me, to make me comfortable and happy.

MOTHER. — Yes, my dear child; and now that you understand some things which you did not know before, which show you that he has taken such good care of you, I hope that whenever anything occurs that you do not comprehend, you will believe that it happens by God's direction, and is designed for your good; and that you will, at some time or other, either in this world or the next, know why and how it happens, and praise God for all his goodness to you, and to your fellow-creatures.



#### QUESTIONS TO CONVERSATION FOURTH.

Can you tell, by looking at them, whether a person's eyes are too round or too flat?

Of how many parts is the eye composed?

What are some of these parts shaped like?

What are *eye-lashes*?

What are *eye-brows*?

Of what use are the eye-lashes and eye-brows?

Of what use are the eye-lashes in the sunshine?



What did the Carthaginians do to the Roman general, Regulus?

What is meant by a *somnambulist*?

What is *winking*?

What is the use of winking?

Why do they who wear spectacles frequently wipe them?

How is the eye shaped in the inside?

What is meant by *wiping* a thing?

How can the eyes wipe themselves?

How has God provided for the protection of the eye?



## CONVERSATION V.

## LIGHT.

CHILD. — MOTHER, I have not yet quite done asking hard questions. I have been thinking a great deal about what you said to me about colors. Now I have thought of something, which I fear is too hard even for you to answer. While I was dressing, this morning, and looking in the glass, I wondered why I could not see myself in the glass in the windows. The looking-glass, on the bureau, looks and feels very much like the glass in the windows; but when I looked at the windows, I could not see myself at all. Can you tell me, dear mother?

MOTHER. — Yes, Caroline, your question is not a very hard one for me to answer ; but it is, perhaps, harder for you to understand, when I attempt to explain it, than anything else which you have asked me. Now, if you will attend to what I say, I will try to make it plain to you.

You recollect that when you threw the ball against the door, and it came back toward you, and the water against my handkerchief, and it remained in the handkerchief, I told you that the colors of light do just the same. When light falls on any object, part of it goes off from the object, and is said *to be reflected*, and part remains in the object, and is said *to be absorbed*.

CHILD. — Yes, mother, and you told me that the colors which are sent back, or are reflected, are the colors which the objects appear to be of; and that although light throws seven different colors on everything, yet none of those colors are seen which are *absorbed*.

MOTHER. — Well, my dear, you must recollect this. Now, suppose that some objects, instead of reflecting or absorbing the colors, should let them all pass through them, — of what color would those objects be?

CHILD. — Why, mother, they would have no color at

all. They could not be black, because they do not absorb the colors; and they could not appear red, nor blue, nor green, nor any of those pretty colors, because they do not reflect them.

MOTHER.—You are right, Caroline; and if the light passes through them, we can also see the light coming through from the objects on the other side. Thus, when you look at the glass in the window, you see the light coming from the objects outside of the window.

CHILD.—Did you say, mother, that we can see the light coming from the objects on the outside of the window? I thought that light comes only from the sun, or the moon, or a lamp, or from fire.



MOTHER.—Yes, my dear, I did say “the light coming from the objects outside of the window,” for if light

did not come from those objects, you could not see them at all.

CHILD.—Why, mother, if father were out doors, and I were looking through the window at him, would he send light in through the window to me?

MOTHER.—You shall answer that question yourself, my dear. Suppose your father had on a beautiful purple robe, such as kings sometimes wear, could you see the robe when looking at him?

CHILD.—Oh, yes, mother! certainly, I could.

MOTHER.—Can you tell me why the robe would appear to be of a purple color, my dear?

CHILD.—Yes, mother! you told me, the other day, that objects which *reflect* the red and the blue colors of light would appear to be of a purple color.

MOTHER.—Well, my dear; then some of the red and the blue colors of light would come from the robe; or, in other words, the robe would send forth some of the light, would it not?

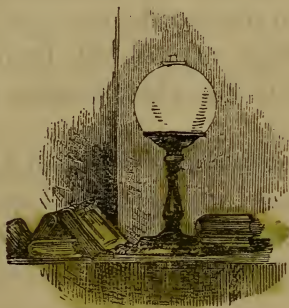
CHILD.—Yes, mother.

MOTHER.—Whatever your father had on would also *send back*, or *reflect*, its own color also. Your father's face, and hands, and coat, and, in fact, his whole figure, would send back, or *reflect*, his exact appearance, would it not?



CHILD.—Yes, dear mother; but what would make the light from father come in through the window to me?

MOTHER.—Now, my child, you are beginning to question me about things which I fear you will not understand; but I will try to make it plain. Listen to me. When the lamps are lighted and placed on the centre-table, at night, to what part of the room does the light which they give go?



CHILD.—Why, mother, it goes to every part of the room, except the dark corners, and under the table, and behind the other furniture.

MOTHER.—But suppose the table and other furniture were of pure white glass, — would not the light pass through them, and go to every part of the room?

CHILD.—Why, yes, mother, it would; and I suppose there would then be no dark corners, as the light would get into them all.

MOTHER.—Yes, my dear! You see, then, that light goes in every direction from the lamp; and it does so from everything else. Everything which you see is seen by means of the colors which it reflects, or absorbs; and wherever you may be, the colors which are reflected must come towards you, or you will not see them. Now, when you look through the window and see your father on the outside, the light which falls on him is thrown back, or reflected, from him in every direction; and it is this which enables you to see him at all.

CHILD.—But, mother, how is it that I can see myself in the looking-glass? I know why I cannot see myself in the window-glass; it is because all the light passes through it. None of it stops in the glass, or is reflected back from it.

MOTHER.—There are some things that absorb all the light—

CHILD.—O, yes, mother, and then they appear all black.

MOTHER.—Yes; and there are others which reflect some of the light or the colors, and absorb the others.

CHILD. — Yes, mother, and they appear of the colors which they reflect.

MOTHER. — And there are some things, like glass and water, for instance, which let all the light pass through them.

CHILD. — Yes, mother, and then we can see other things through them.

MOTHER. — Now, Caroline, I must tell you, that there are some things that reflect all, or most all, of the light which falls upon them, and absorb little or none. When we look at them, we cannot see them, — we only see the light and the colors which they reflect.

CHILD. — Oh! now I understand, mother, why I can see myself, and other things, in the glass. I do not see the glass, but only the colors which fall from other things on the glass, and are reflected from it. The light that comes from me falls on the glass, and is reflected back to me, and I see myself in the glass.

MOTHER. — Yes, my dear; but you must not forget that I have not yet answered your question — *Why you can see yourself in the glass on the bureau, and not in the glass on the window?*

CHILD. — I was just going to ask you that question again, mother; for although I understand why I cannot see myself in the window-glass, I do not understand

why the light will not pass through the glass on the bureau.

MOTHER.—It will, my child, and does; and you see in the glass on the bureau the light that comes from the other side.

CHILD.—Why, mother, I cannot see through the looking-glass; and besides, if I did, I see myself there while I am standing *before the glass*, and on this side of it, not on the other.

MOTHER.—And are you quite sure, my dear, that you know what is on the other side of the glass?

CHILD.—Why, yes, mother; there is nothing there except a thin board for the back of the glass, and the wall behind the board.

MOTHER.—And what prevents your seeing the thin board which forms the back of the glass? Is there not something else on the back of the glass itself? Look here; here is a small piece of a broken looking-glass. See what this is.

CHILD.—It looks, mother, like lead; or like silver that is not bright.

MOTHER.—And now I have scratched a little of it, with my scissors, from off the glass. Look, now, at the other side of the glass, and tell me what you can see.

CHILD.—Why, mother, I can see directly through

that part of the glass where you have scraped off that dull-looking stuff.

MOTHER.—Then it is what you call “that dull-looking stuff” that prevents the light from passing through the glass?

CHILD.—Yes, mother; but how is it that that dull-looking stuff looks so bright when I look at it through the glass? On the back it looks rough and dull, and on the front it looks bright and smooth.

MOTHER.—Have you never seen, my child, when Alice has baked her little cakes in cups, that the cakes look dull and rough on the top, but the sides and bottom, which were formed against the smooth sides and bottom of the cup, were smooth and bright, and sometimes shine like glass?

CHILD.—Oh yes, mother; and this is always the case when she rubs a little butter on the sides of the cups.

MOTHER.—Very well; and the sides of the cups feel smoother when the butter is rubbed on them, do they not?

CHILD.—Yes, mother, but when I asked Alice why she put the butter on the cups, she told me it was to make the cakes slip out easily after they were baked, and prevent their sticking to the cups.

MOTHER.—Precisely so, my dear. Now, you said



that the cakes always appear to shine most, and are smoothest, when the butter is rubbed on the cups. But the cups themselves, although very smooth, are by no means so smooth as glass. If, then, the cakes formed in the cups become so smooth at the sides, where they are pressed against the smooth sides of the cup, I suppose that you can tell the reason why this "dull-looking stuff" which is spread on the side of the smooth glass looks so bright and smooth through the glass?

CHILD.—Yes, mother, but I do not understand why the light does not pass through it.

MOTHER.—The light will not pass through it, my dear, because it is a metal, or rather a mixture of two metals; and light cannot pass through any metal. It is the bright and smooth metal, on the back of the glass, that reflects the light, and not the glass itself.

CHILD.—Why, then, mother, is the glass put over the metal at all, if it is the metal which reflects the light, and not the glass?

MOTHER.—The glass is put over the metal for two reasons: first, to give the metal a smooth surface, so that it may reflect the light well; and, secondly, to prevent the metal from growing dull by exposure to the air. You know that Alice is frequently employed in scouring and polishing her tin cooking utensils, and

her brass kettles, and the brass handles of the kitchen doors, and the knives, and the silver forks and spoons; and in a few days she has to scour or polish them again, because, by use, and by exposure to the air, they lose their brightness, and look dull. So it would be with the metal on the back of the looking-glass, if it were not covered by the glass. The glass protects it from the dust and the air, and keeps it smooth and bright. You see, on the other side, the metal looks, as you said, quite rough and dull.

CHILD. — Yes, mother, but do all smooth and bright things reflect the light, like the metal behind the glass?

MOTHER. — Before I answer that question, my dear, I must make you understand *the difference between smooth and soft*. Draw your hand over the velvet on my bonnet.

CHILD. — How very soft and smooth it feels, mother!

MOTHER. — No, my dear, not *smooth*; but it is, as you say, very *soft*. Now draw your hand over the surface of that marble slab on the centre-table.

CHILD. — Oh yes, mother, that is very smooth, but not soft; is it not, mother?

MOTHER. — Yes, my dear; and now I hope you will understand me when I say that there is a great difference between *soft* and *smooth*. One thing may be

smooth but not soft, like the marble slab; and another may be soft but not smooth, like the velvet. Smooth means *even on the surface*; soft implies *yielding to the slightest pressure*. Now, if you draw your hand over the marble slab backwards and forwards several times, you will find that it feels smooth, whichever way you move your hand. This shows that it is smooth. But if you do the same to the velvet, or on puss's back, you will find that both feel *soft*, but neither of them are *smooth*; for when you carry your hand backwards, they both feel a little rough. Now, all things which have a smooth surface reflect the light well; and the smoother they are, the more light they appear to reflect.

CHILD. — And are they not *brighter*, too, mother?

MOTHER. — What do you mean by *bright*, my dear?

CHILD. — Why, do not you know, mother, what *bright* means? Why, it means shining, or full of light, reflecting much light.

MOTHER. — And what did I just tell you reflects most light; that is, appears most full of light, and shining?

CHILD. — You said, mother, that the smoother anything is, the more light it appears to reflect.

MOTHER. — Then the smoother anything is, the brighter it must appear also.

CHILD. — Oh yes, mother; and the reason that the

marble slab appears so bright is because it is so smooth, is it not?

MOTHER. — Yes, my dear. When the slab was made, it was first sawed out of a piece of solid marble, and looked rough and dull, like any other stone; but when it was smoothed, it then began to reflect more light; and when it was polished, that is, made more smooth, it looked bright, because it reflected still more light.

CHILD. — But, mother, I have seen a great many things which appear bright, but I am sure they are not smooth. Alice the cook, the other day, accidentally broke a piece of iron out of the grate, and the edges of the broken part looked quite bright, while all the rest of it looked very black. I felt of the broken edge, and it felt sharp and rough. It was not smooth, mother, but it was quite bright.

MOTHER. — You say, Caroline, that it was not smooth. Perhaps the whole surface was not so, but there must have been small places on the surface which were smooth, and perhaps a great many of them; and these all reflecting the light, made the whole surface look bright.

CHILD. — You said, mother, that the *light* from the lamp, and from everything else, *goes in a straight line, in every direction*. Now, if this is the case, what is the



reason that I cannot always see myself, and the floor, and all the chairs and tables, and other things, all at once, in the looking-glass? You say that the light from all these things strikes through the glass, on the bright surface of the metal behind the glass, and is thrown back again, or reflected, by the metal. If this is true, what is the reason that I cannot always see myself, and the other things too, in the glass? You know, mother, I cannot see myself in the glass here where I stand; but I must go and stand before it, if I want to see myself.

MOTHER. — That is very true, my dear, and I expected that you would ask that question. But before I answer it I must make you take your little ball, and practice a little with that.

CHILD. — My little ball, mother! that is very strange. How can my little ball teach me anything about a looking-glass?

MOTHER. — It may appear very strange, my child, until you understand that when light strikes against anything which will reflect it, it acts just as if every particle of it were a little ball; and bounds off, or is reflected, just as a little ball bounds off when thrown against the wall, or the ceiling, or the door, or the floor.



CHILD.—How very wonderful, dear mother! pray explain it to me.

MOTHER.—Well, Caroline, take your little ball, and stand directly before the door, and throw it as straight as you can, directly at the door, and near the middle, and tell which way it bounds back from the door.

CHILD.—Why, mother, it comes directly back, almost into my hand.

MOTHER.—Now, my dear, stand a little to the right, and throw it again, as near as you can, at the same spot, on the door, and tell me then which way it goes.

CHILD.—It has gone towards the other side of the room, mother.

MOTHER.—Take the ball once more, Caroline, and stand as far to the left of the door as you now are to the right, and throw the ball again at the same spot on the door, and then tell me which way the ball rebounds.

CHILD.—Why, mother, it has gone now toward the side where I was before, on the right side of the door. But do tell me, mother, what this has to do with the looking-glass.

MOTHER.—Do you not recollect, my dear, that I told you that the light goes against anything which reflects it, precisely as if it were all made of little balls. Now,

just for a moment, suppose the door to be a looking-glass, and that you were a lamp, and that the little ball which you threw against the door was a very small portion of light. Can you not tell me which way the light would go from the looking-glass?

CHILD.—Oh, yes, mother; now I see through it all. When I stand directly before the glass, the light which goes from me to the glass comes right back to me from the glass; and when I stand to the right of the glass, the light does not return to me, but goes off to the left of the glass; and when I stand to the left, the light goes off to the right. Is it not so, mother?

MOTHER.—Yes, my dear; and now let us both go and stand directly before the looking-glass a moment, in order that you may see and understand this more clearly.

Now we are directly before it, we can both see ourselves, as you observe.

CHILD.—Yes, mother; but look—see—in the glass your thimble appears to be on your left hand; and my ball, too, which I have got in my right hand, appears, in the glass, to be in my left hand; and I, who am on your left side, appear, in the glass, to be standing on your right. What is the reason of that, mother?

MOTHER.—I think you will be able to tell me your-

self presently, my dear. But be patient, and listen to me. Now do you stand a little to the right of the glass, and I will stand at the same distance to the left.



Let us be exact; and in order that we may be exact, first go to my work-box and bring me that little yard measure, which rolls up in the ivory case, and then we will measure our distance from the front of the glass.

There, here is the front of the glass, and I am going to measure on the floor two yards each side of the front of the glass; and you shall stand two yards to the right, and I will stand two yards to the left, and then let us look into the glass.

CHILD.—Why, mother, I cannot see myself now; but I can see you.

MOTHER.—And I, my child, cannot see myself; but I can see you. Now, stand still where you are, while I measure a yard more to the left, and take my stand there.

CHILD.—I cannot see you now, mother, in the glass.

MOTHER.—No, my dear; neither can I see you, because I am a yard further to the left than you are toward the right. But take the measure and move another yard towards the right.

CHILD.—Oh, now I can see you again, mother.

MOTHER.—Very well; because now you and I are both at the same distance from the front of the glass. You are three yards to the right, and I am three yards to the left, of the front of the glass; and wherever you stand, to the right or the left of the glass, you see in the glass those things only which are just so far on the other side. Now, you see, my dear, that the light acts just as the ball did when you threw it against the door. When you stood in front of the door, and threw the ball at the middle of the door, the ball returned to you in front; but when you stood at the right of the door, the ball bounded off to the left;

and when you stood on the left, the ball bounded off to the right.

CHILD.—O yes, dear mother; how surprising it is! But why did your thimble, mother, appear in the glass to be on your left-hand finger?

MOTHER.—Let me first ask you, Caroline, whether you did not perceive any other singular appearance of the same kind, when you were looking in the glass?

CHILD.—No, mother, I did not.

MOTHER.—The glass is on the easterly side of the room; and when you were looking at it, toward which side of the room were you facing?

CHILD.—Why, mother, I was looking, of course, at the easterly side, where the glass is, and where the east window is, where the sun comes so beautifully, early in the morning.

MOTHER.—And which way was the picture of yourself, in the glass, facing?

CHILD.—Why, mother, it was facing the east window, too.

MOTHER.—Are you sure? Now go to the glass again, and see.

CHILD.—Why, mother, how strange! while I am facing the east window, my picture in the glass seems to be facing the west window.



MOTHER.—And now, my dear, hold up your right hand, and tell me which hand your image in the glass holds up.

CHILD.—Dear mother, how very singular! the image in the glass is holding up its left hand. It will not do anything exactly as I do it.

MOTHER.—And can you not see the reason, my child?

CHILD.—I cannot say, mother, that I do, very distinctly.

MOTHER.—Think what the ball which you threw against the door, did.

CHILD.—O, yes, mother! the ball rebounded in a direction opposite to that in which I sent it; and you told me that light goes just like the ball. When I sent the ball *to* the door, it rebounded *from* the door; and when I sent it to the right, it rebounded to the left; and when I sent it to the left, it rebounded towards the right. Now, if, as you say, it is just so with the light, that which comes from the left must go to the right, and that which comes from the right must go to the left; and in the looking-glass my right hand must appear to be the left, and the left hand must appear to be the right. Is it not so, mother?

MOTHER.—Yes, it is.

CHILD.—O how strange, dear mother!—and if I had a scar on my right cheek, the looking-glass would make it appear on my left.

MOTHER.—Yes, my dear; the looking-glass reverses everything. Now, Caroline, if you were standing on a high table in front of the looking-glass, and *looking down* on the looking-glass, can you tell how your image on the glass would appear?

CHILD.—Why, mother, it would appear to be *looking up* at me, would it not?

MOTHER.—Certainly, it would; and now I am going to tell you something which is still more strange, and that is, that you can see your whole figure, from head to foot, in a glass which is only half as tall as you are.

CHILD.—Do tell me, mother, how that can be?

MOTHER.—I told you, some time ago, my dear, that there are some things too difficult for you to understand at present; and this is one of them. I will only tell you now the fact as I have mentioned it, and that must satisfy you for the present. When you are older, you will understand it more easily, and will see that the same cause which makes your right hand appear to be the left, and the left to be the right, enables you to see your whole self in a glass of only half your length. There are a great many other things about light, and about

looking-glasses, which are equally interesting with what I have told you; but I think it better to wait until you are older, before I attempt to explain them. In the mean time, I would have you think how great a blessing light is, and how thankful we should be to our good Creator "for all the blessings of the light."

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#### QUESTIONS TO CONVERSATION FIFTH.

What becomes of the light which falls on any object?

When is the light said to be reflected?

When is the light said to be absorbed?

Of what color do all objects appear to be?

How many different colors does light throw on every object?

Of what color will those substances be, which cause all the light that falls on them to go through them?

When you look through a glass window, what do you see?

Why do some objects appear of a purple color?

How is it that we are enabled to see objects through the glass in the window?

When the lamps are lighted at night, to what part of the room does the light go?

Suppose all the objects in the room were transparent, or were made of pure white glass, would there then be any dark corners in the room?

How is everything seen?

How do all objects appear that absorb all the light that falls on them?

What can you see in a looking-glass?

What is on the back of a looking-glass?

Why will not the light pass through the back of a looking-glass?

What reflects the light from a looking-glass?

Why is glass put over the metal at the back of a looking-glass?

Do all smooth and bright things reflect light like a looking-glass?

What is the difference between *soft* and *smooth*?

What does *bright* mean?

In what direction does light always move?

When light strikes against a substance that reflects it, how does it act?

When you stand directly before a looking-glass, where does it throw your reflected image? Where, when you stand at the right side? Where, when you stand at the left side?

Does the looking-glass make all things appear as they are?

When you see a person in a looking-glass, can that person see you, also, if he looks in the glass?

How large must a looking-glass be, to enable you to see your whole figure?



## CONVERSATION VI.

## FIRE.

CHILD.—MOTHER dear, you told me, the other day, that nobody knows what *light* is, except the Great Creator. Now, can you tell me *what fire is*?

MOTHER.—I fear, my child, that you have asked another question which I cannot directly answer. What fire is, is known only by its effects.

CHILD.—And what are its effects, mother?

MOTHER.—Some of its effects are as well known to



you, my dear, as they are to me; and I shall, in the first place, call to your recollection what you yourself know about *fire*, before I attempt to give you any further information in relation to it.

CHILD.—Why, mother, I am sure I do not know what fire is.

MOTHER.—No, my dear, I know that you do not know what fire is; neither do I, nor does any one, except the Great Creator himself. This is one of his secrets, which, in his wisdom, he reserves for himself. But you certainly know some of the effects of fire. For instance, you know that when you have been out into the cold, you wish, on your return, to go to the fire. Now, can you tell me what you go to the fire for?

CHILD.—Why, certainly, mother; I go to the fire to warm myself.

MOTHER.—And how does the fire warm you, my dear?

CHILD.—Why, it sends out its heat, mother; and I hold out my hands to it, and feel the heat.

MOTHER.—Very well; and where does the heat come from?

CHILD.—Why, the heat comes from the fire, mother.

MOTHER.—Then, my dear, you know at least one of the effects of fire. It produces, or rather sends out, heat.

CHILD.—But does not the fire make the heat, mother?

MOTHER.—If you had a little bird, or a mouse, in a cage, and should open the door and let it out, should you say that you *made* the little bird or the mouse?

CHILD.—Say that I made them, mother?—why, no; certainly not. I only let them go free. God made them. You told me that God made all things.

MOTHER.—Neither did the fire make the heat. It only made it free, somewhat in the same manner that you would make the bird or the mouse free, by opening the door of the cage.

CHILD.—Why, mother, is heat kept in cages, like birds or mice?

MOTHER.—No, my dear, not exactly in cages, like birds and mice; but a great deal closer, in a different kind of cage.

CHILD.—Why, mother, what sort of a cage can heat be kept in?

MOTHER.—I must answer your question, Caroline, by asking you another. When Alice makes her fire in the kitchen, how does she make it?

CHILD.—She takes some wood, or some coal, and puts under it some pine wood, which she calls kindling, and

some shavings, and then takes a match and sets the shavings on fire, and very soon the fire is made.

MOTHER.—But does she not first do something to the match?



CHILD.—O, yes; I forgot to say that she lights the match first, and then sets fire to the shavings with the lighted match.

MOTHER.—But how does she light the match, my dear?

CHILD.—Why, mother, have you never seen her? She rubs one end of the match on the box, where there

is a little piece of sand-paper, and that sets the match on fire.

MOTHER.—Is there any fire in the sand-paper, my dear ?

CHILD.—Why, no, mother ; certainly not.

MOTHER.—Is there any fire in the match, before she lighted it ?

CHILD.—Why, no, mother ; if there had been, she would have had no need to light it.

MOTHER.—You see, then, that fire came when she rubbed the match against the sand-paper, and that the fire was not in the sand-paper, nor in the match.

CHILD.—Yes, mother, but I did not see where it came from.

MOTHER.—I am going to explain that to you, my child. Did you ever see a person rub his hands together, when he was cold.

CHILD.—O yes, mother, a great many times. I have seen father come in from the cold and rub his hands together, and afterwards hold them to the fire and rub them again, and then they get warm.

MOTHER.—And now, Caroline, take your hand and rub it quickly backwards and forwards, over that woollen table-cloth, on the table in the corner of the room, and tell me whether that will make your hand warm.

CHILD.—O, yes, dear mother; I feel it grow warmer the faster I rub it.

MOTHER.—Here are two small pieces of wood. Touch them to your cheek, and tell me whether they feel warm now.

CHILD.—They do not feel warm, nor cold, mother.

MOTHER.—Now rub them together quickly a little while, and then touch them to your cheek.

CHILD.—O dear, mother! they are so hot that they almost burnt my cheek.

MOTHER.—Yes, Caroline; and do you not recollect, when you read Robinson Crusoe, that his man Friday made a fire by rubbing two pieces of wood together.



CHILD.—O, yes, dear mother; and I have often wondered why Alice could not light her fire and the lamp in the same manner, without those matches, which have so offensive a smell.

MOTHER.—It is very hard work, my dear, to obtain fire by rubbing two pieces of wood together; and it would take too long a time to do it. The two pieces of wood would grow warm by a very little rubbing;



but in order to make them take fire, they must be rubbed together a great while.

CHILD.—But, mother, if it takes so long a time to get fire by rubbing two pieces of wood together, why can Alice set the match on fire so easily by rubbing it once on the sand-paper?

MOTHER.—That is what I am about to explain to you, my dear. Here, take this piece of paper and hold it up to the lamp.

CHILD.—It has taken fire, mother.



MOTHER.—Now take this piece of pine wood, and hold that up to the lamp in the same manner, and see whether that will take fire too.

CHILD.—Yes, mother, it has taken fire; but I had to hold it up to the lamp much longer than I did the paper.

MOTHER.—Now take this piece of hard wood, and do the same with that.

CHILD.—The hard wood takes longer still to catch fire, mother.

MOTHER.—Very well; and now I am going to make the hard wood take fire more quickly than the paper did.

CHILD.—Dear mother, how can you do it?

MOTHER.—I am now going to show you. Here is a small phial, which contains something that looks like water. It is spirits of turpentine. I shall dip the point of the piece of hard wood into the phial, and take up a little of the spirits of turpentine. Now, my dear, touch the point of the hard wood with the turpentine on it to the flame.

CHILD.—Why, mother, it caught fire as soon as I touched the flame with it!

MOTHER.—Yes, my dear; and you now see that some things, like the spirits of turpentine and the paper, take fire very readily, and others take fire with more difficulty.

CHILD.—Yes, mother; but when Alice drew the match across the sand-paper, there was no flame nor fire to touch it to. How, then, could it take fire?

MOTHER.—Hold this piece of paper up to the blaze of the lamp, my dear, but be careful not to touch the fire or flame of the lamp; only hold it close to the blaze.

CHILD.—Why, mother, it has taken fire!

MOTHER.—You see, then, that a thing will sometimes take fire when it does not touch the fire.

CHILD.—Yes, mother; but I do not understand where the fire comes from.

MOTHER.—The fire comes from the heat, my dear. Now, you know that heat is produced by rubbing two things together; and that some things, like the spirits of turpentine, take fire very easily, or with very little heat; and others, like the hard wood, require to be heated some time; or, in other words, require much heat, to make them take fire, or to burn. Some things require only as much heat to make them take fire as can be obtained by rubbing them together very quickly, like the wood which Robinson Crusoe's man Friday used.

CHILD.—But, mother, the match is made of wood; why does that take fire so easily?

MOTHER.—It is true, Caroline, that the match is made of wood; but it has something at the end of it, which takes fire much more easily than the spirits of turpentine. Indeed, so easily does it take fire, that it requires only so much heat to set it on fire as is obtained by drawing the match once across the sand-paper.

CHILD.—But, mother, matches do not always take fire. I have seen Alice rub several across the sand-paper, before she can set one on fire.

MOTHER.—Yes, my dear, and the reason of this is, that the matches are not all well made. Now, if I should take several pieces of hard wood and tie them together, and dip their ends into the spirits of turpen-

tine, what would happen if the ends of some of the pieces did not touch the spirits of turpentine, because I had not tied them together with their points all even?

CHILD.—Why, mother, some of them would take fire easily, because the points had the spirits of turpentine on them; while those which did not touch the spirits could not be lighted so easily.

MOTHER.—So it is, my dear, with the matches. They are all dipped into the substance which takes fire so easily; but some of the ends do not reach the substance, and do not become coated with it, and therefore they will not light more easily than the pine wood of which they are made.

CHILD.—Well, mother, I understand, now, how the match is set on fire. It is rubbed on the sand-paper, and that produces heat, and the heat sets the match on fire. But I always thought that fire makes heat, not that heat makes fire.

MOTHER.—Heat does not always make fire; for if it did, everything would be on fire.

CHILD.—Everything on fire, mother! why, what do you mean?

MOTHER.—I mean, Caroline, that everything contains heat.

CHILD.—Everything contains heat, mother, did you

say? Why, then, is not everything warm? Some things, mother, are very cold; as ice, and snow, and that marble slab.

MOTHER.—Yes, my child, everything contains heat, as I shall presently show you. When Alice goes to make a fire in a cold day, she does not carry the heat with her, and put it into the fire, nor into the wood, nor the coal, does she?

CHILD.—Why, no, to be sure not, mother.

MOTHER.—And the heat that comes from the fire, after it is made, does not come in at the windows nor down the chimney, does it?

CHILD.—Why, no, mother; it feels cold at the windows, and cold air comes down the chimney.

MOTHER.—But, after the fire is made, we feel much heat coming from the fire, do we not?

CHILD.—Why, yes, mother; that is what the fire is made for. We feel cold, and we want a fire to make us warm; and when the fire is made, it sends out heat, and makes us warm.

MOTHER.—Well, now, where can the heat come from? You know what fire is made from, do you not?

CHILD.—Certainly, mother; the fire is made of wood, or of coal.



MOTHER.—But is the wood or the coal warm before the fire is made?

CHILD.—No, mother, the wood and the coal come from the cold wood-house, or the cellar, and they are both very cold.

MOTHER.—And yet the wood and the coal become very hot when they are on fire.

CHILD.—Oh yes, mother, so hot that we cannot touch them with our hands, and we have to take the shovel or the tongs to move them.

MOTHER.—And do they burn the shovel and the tongs, my dear?

CHILD.—Why, no, mother; if they did, the shovel and tongs would be of little use in stirring the fire.

MOTHER.—Can you think of any reason why they do not burn the shovel and the tongs?

CHILD.—You told me, mother, that some things require a very little heat to set them on fire, and that other things require a great deal. I suppose that there was not heat enough to set them on fire; and if there had been, they would not burn, because they are made of iron.

MOTHER.—You are partly right, my dear, and partly wrong. They would not burn, because there was not heat enough in the fire to burn them. But there are

very few things, and in fact it may be doubted whether there is anything, which will not burn, when sufficient heat is applied. But let us return to the fire: you say the heat does not come from the windows nor from the chimney, and you say, also, that the wood and the coal are both cold. Now, where can the heat come from?

CHILD.—I am sure I cannot tell, mother; will you please to tell me?

MOTHER.—You recollect that I told you that the rubbing of the match on the sand-paper produces a little heat, which caused the match to burn. The match was then applied to the shavings, and, as it was burning, gave out heat enough to set the shavings on fire; the shavings produced heat enough to set the pine wood, or kindling, on fire, and then the pine wood, or kindling, produced more heat, and set the wood and coal on fire. Now, there was nothing to produce the heat but the match, the shavings, the wood, and the coal; and *the heat must have been in them*. The fire only served to set it free, and let it come out of the match, the wood, and the coal.

CHILD.—But, mother, how did the heat get into the wood and the coal?

MOTHER.—It is not known, my dear, how the heat

*got into* the wood and coal, any more than how the fruit gets on to a tree. We say that it grows on the tree; but what growing is, and how it is caused, are among the secrets of God.

CHILD.—If the heat is in the wood and the coal, mother, why do we not feel it in them? They both feel cold, I cannot perceive any heat in them.

MOTHER.—The heat is in the wood and the coal, although you do not see it. Do you see any smoke in the wood and the coal?

CHILD.—No, mother, I do not,



MOTHER.—Did you never see a stick of wood fall on the hearth from the kitchen fire, and see the smoke coming from it?

CHILD, — Oh yes, mother, very often; and the smoke goes all over the room, and into my eyes, and makes the tears come into my eyes.

MOTHER, — And can you see the smoke in the wood before the wood is put on the fire?

CHILD, — No, mother, I am sure I cannot,

MOTHER, — But you are sure that the smoke comes from the wood, are you not?

CHILD, — Oh yes, mother, I see it coming right out of the wood?

MOTHER, — Well then, I suppose you know that if there is something in the wood and coal, which you call *smoke*, although you cannot see it until it comes out, you can easily conceive how another thing, which we call *heat*, can be in the wood and coal, which we cannot perceive until it is made to come out.

CHILD, — Oh yes, mother; how wonderful it is!

MOTHER, — Yes, Caroline, all the works of God are wonderful; and what is very surprising is, that many of his most wonderful works are so common, so continually before our eyes, that we do not deem them wonderful until we have been made to think much about them, by talking about them, as you and I have talked about the rain, and the clouds, and light, and its colors.

CHILD. — I have been thinking, mother, about Alice and the fire. You told me that the fire did not *make* the heat, any more than I *make* the little mouse or the bird when I open the cage door and let them out. I see now how it is. Alice brings the wood and the coal into the kitchen fireplace, and the match lets the heat out of the shavings, and the shavings let it out of the wood and the coal, until we get heat enough to make us warm.

MOTHER. — Yes, my dear; and there is no more heat in the room after the fire is made than there was before, — only, before the fire was made the heat was hid, and we could not perceive it; but when the fire is made, it makes the heat come out, and makes it free, just as I make the little bird free by opening his cage door.

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#### QUESTIONS TO CONVERSATION SIXTH.

How do we know what fire is?

What does the fire send out?

Does the fire make the heat which it sends out?

What does the fire do to the heat?

How is a fire made?

How is a match lighted?

Is there any fire in the match, or in the sand-paper?

Why does a person rub his hands when he is cold?



When two pieces of wood are rubbed together quickly, what effect is produced?

How did Robinson Crusoe's man Friday make a fire?

Why is not fire generally made by rubbing pieces of wood together?

How can you make hard wood take fire easily?

Why does the wood of which matches are made take fire so easily?

Why do not matches always take fire?

Does heat always make fire?

What things contain heat?

Where does the heat come from, when a fire is made?

What is the reason that the shovel and tongs do not take fire?

Where does smoke come from?



## CONVERSATION VII.

## HEAT.

CHILD.—MOTHER, you told me a great many things about fire, and how it made heat free. Now, mother, is not fire the same as heat, and heat the same as fire? Are they not both alike?

MOTHER.—No, my dear; for although there can be no fire without heat, there may be heat without fire, as I will now show you. Here is a small bottle, which contains something that looks like water, only it looks a little yellow. You must be careful not to touch it, for it will burn like fire; and if a drop of it falls on

your dress, it will make a red spot in it, and then make a hole through it.\* You may feel the outside of the phial, and you will perceive that it feels cold. Now go and bring a tumbler, and a pitcher of cold water. Now, I am going to pour a little of the liquid from the phial into the tumbler, and then pour some cold water also into the tumbler; and as the water mixes with the fluid in the tumbler, I wish you to feel of the outside of the tumbler.

CHILD.—Dear mother, how hot the tumbler is! I can scarcely hold it in my hand, it is so warm.

MOTHER.—But there is no fire in the tumbler, is there?

CHILD.—No, mother; there is none that I can see.

MOTHER.—But you say that there is a great deal of heat in the tumbler. You see, then, that there can be heat without fire, although there can be no fire without heat.

CHILD.—Oh yes, mother; but where does the heat come from?

MOTHER.—I think I told you, in our last conversation, that there is heat in everything, but that it is *hidden*, until something makes it come out. When the

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\* The fluid represented in the phial is sulphuric acid, or vitriol.

heat is taken out of water, do you know what water becomes ?

CHILD.—No, mother ; I never saw water with heat taken out of it. You told me, in our first conversation, that heat changes the water into steam ; and that when the steam is cold, it turns back again into water.

MOTHER.—But what does water do, when it is put out into the cold, in a very cold day ?

CHILD.—Why, mother, it freezes, and becomes ice.

MOTHER.—What makes it become ice ?

CHILD.—I do not know, mother, unless it is the cold.

MOTHER.—Can you tell me, Caroline, what the ice will do, if you bring it into a warm room, or hold it in your hand, or in your mouth ?

CHILD.—Why, mother, it melts, and becomes water again.

MOTHER.—What makes it melt, or become water again ?

CHILD.—I do not know, mother, unless it is the heat of the fire, or the warmth of my hand, or of my mouth ?

MOTHER.—Exactly so, my dear ; the heat has changed it from ice to water. Now, if the heat that has got into the ice and changed it to water could be taken away from the water, what would the water become ?

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CHILD.—I do not know, mother, unless it would change it back again into ice.

MOTHER.—After the heat has changed the ice into water, can you tell me what it will do, if more heat is applied to the water?

CHILD.—Why the water would boil, mother, if there was sufficient heat.

MOTHER.—And when the water boils away, where does it go to?

CHILD.—O, I recollect now, mother, you told me that boiling away means only that heat has changed the water into steam.

MOTHER.—Well, then, Caroline; if the heat be taken away from the steam, or if the steam becomes cold again, what will be the effect?

CHILD.—Why, mother, the steam would then be changed to water.

MOTHER.—Very well; and if we take away from water more heat still, and thus make it very cold, what will the water then become?

CHILD.—Why, mother, when the water is made very cold, it becomes ice.

MOTHER.—You see, then, my child, that heat produces great changes in water. When water is frozen, heat changes the ice back into water; and when the



water is made very hot by the addition of much more heat, the heat changes the water into steam.

CHILD. — What is cold, mother?

MOTHER. — Cold, Caroline, is nothing but the absence of heat; just as darkness is merely the absence of light.

CHILD. — But cold can be added to things, in the same way that heat may be added. When anything is made hot, if we add more heat to it, it becomes hotter; and when a thing is cold, if we add more cold to it, it becomes colder; does it not, mother?

MOTHER. — We cannot add cold to anything, any more than we can add darkness to any place. A dark place can be made darker, not by adding darkness, but by stopping up all the means by which light can approach it. So a thing becomes colder, not by adding more cold, but taking away what heat there is remaining in it.

CHILD. — What is heat, mother?

MOTHER. — That is another of God's secrets, my dear. He has not permitted us to find out what heat is; but although we do not know what heat is, we do know a great many things about it.

CHILD. — That is what you told me about light, mother. You said that we do not know what light is, but we do know a great many things about it.

MOTHER.—Heat, my dear, is very much like light, in that respect, and in some others too. You have seen that light is reflected, or thrown back, from many smooth surfaces. Heat is likewise reflected in the same way.

CHILD.—Heat reflected, mother! does heat reflect its colors, like light?

MOTHER.—No, my child, it does not reflect its colors. We do not know that heat has any color.

CHILD.—Why, mother, do not you recollect, the other day, that you blamed Alice for carelessly leaving her irons on the fire too long, because they became *red hot*. Now, if heat has no color, how can a thing become *red hot*?



MOTHER.—Heat has the power of *changing* the colors of some things, my dear, but not the power of

*making* them. Did you ever hear of an iron's becoming *black hot*?

CHILD.—No, mother; but the irons are hot when Alice irons or presses the clothes that she has washed, and they are also black. Is that what you mean, mother, by *black hot*?

MOTHER.—That would be what I meant, my dear, if I meant anything. I only wanted to convey to you the idea that heat has no color. And yet we do sometimes speak of heat as if it had color. You told me that the iron was hot, and was black; and that when Alice carelessly left it on the fire too long, it became red. Now I wish you to notice the coal which is burning in the grate, and tell me of what color it is.



CHILD.—All around the outside, mother, the coal looks black; and further into the fire, it looks red.

MOTHER.—Now look right at the middle of the fire.

CHILD.—Why, right in the middle, mother, the coal is almost white, and looks as if it were very hot there.

MOTHER.—You are right, my dear; it is intensely hot there. The color of the coal shows the *degree* of heat, not the *color* of heat. You know that where the coal appears red, it has kindled and become on fire; it is therefore *hotter* than the black coal: and where the coal appears almost white, in the middle of the fire, there is more heat there, because it is surrounded on all sides by the burning coals.

CHILD.—Then, heat is more powerful than light, is it not, mother?

MOTHER.—Certainly it is; for you see how easily heat appears to change the color. But that is not all. Can you tell me what effect heat has on the butter, when Alice spreads the butter on hot toasted bread?

CHILD.—Yes, mother; it melts the butter.

MOTHER.—Does it not change its color first?

CHILD.—O yes, mother; it changes the beautiful yellow color of butter, and makes it liquid, like water.

MOTHER.—And what does heat do to ice and to water; does it not change the color of them also?

CHILD.—Yes, mother; it makes the ice melt, and

changes it from ice into water ; and it turns the water into steam.

MOTHER.—You see, then, Caroline, that heat not only changes the color, but also the form, of many things. Now, can you tell me what it does to the wood and the coal on the fire ?

CHILD.—It first makes them turn red, and then makes them turn white, and then burns them up.

MOTHER.—What do you mean, my dear, by “burning them up” ?

CHILD.—Why, mother, it keeps heating them more and more, until they are all gone, and no more wood or coal remains.

MOTHER.—And does nothing remain after the wood and coal are burnt up ?

CHILD.—Nothing, mother, but ashes, and sometimes some dead coal, that looks black, or is covered with ashes.

MOTHER.—And what is ashes ?

CHILD.—Ashes, mother, is what remains after the wood and coal have burnt up.

MOTHER.—And do you not now see, Caroline, that this is the effect of heat on the coal and the wood ?

CHILD.—O yes, dear mother, the heat changes the wood and the coal into ashes ; does it not, mother ?



MOTHER.—Yes, my dear; and does not heat convert the wood and coal into something else besides ashes?

CHILD.—I do not know, mother. I do not see anything else in the fireplace, except some dead coals, when the fire has gone out.

MOTHER.—Did you not see the smoke come from the wood and the coal, and go up the chimney?

CHILD.—O, yes, mother; the heat changes the wood and the coal into smoke and ashes.

MOTHER.—And the smoke goes up the chimney, and the ashes fall down into the fireplace. Can you tell me why the smoke goes up and the ashes fall down?

CHILD.—I recollect that you told me, when we were talking about the rain, that things which are lighter than the air will rise in the air, just as steam rises; and that things which are heavier than air will fall. I suppose, then, that the smoke is lighter, and the ashes heavier, than the air.

MOTHER.—You are right. Now, Caroline, can you tell me anything else which is produced, when heat converts the wood and coal into ashes?

CHILD.—I see nothing else, dear mother.

MOTHER.—But do you not smell something when coal is burning?

CHILD.—O yes, mother; when the coal fire is made,

I perceive a smell very much like that which is made when Alice lights a match.

MOTHER.—And where do you think the smell comes from?

CHILD.—I am sure that I do not know, mother.

MOTHER.—The coal has no smell before it is burning; but, as soon as it burns, the smell comes from the coal.

CHILD.—Oh, yes, mother; I see, now, that the heat makes the smoke and the smell come out from the coal, and then turns the coal into ashes.

MOTHER.—Yes, but you cannot see the smell, can you?

CHILD.—No, mother, I cannot see it, any more than I can see the heat.

MOTHER.—But it must *be* something, otherwise you could not perceive it. You see, then, that heat changes the wood and the coal into ashes and smoke, and something else, which you can smell.

CHILD.—Yes, mother. And now can you tell me what heat is?

MOTHER.—No, my dear, I cannot tell you what heat is. All that is known is, that it is something which exists in everything, but is *hidden* until something causes it to come out; and when it does come out, it

produces great changes in different things. In some things it produces very little change, as you see in the bricks in the fireplace, and the iron bars of the grate; but if a burning coal should fall on the carpet, or the floor, you know that it would burn a hole.

Now, you saw, when Alice lifted the lid of the tea-kettle, a large cloud of steam came out, which you said went all over the room. I explained to you that the steam was water heated, and that when the heat was taken away, the steam became water again. Now can you tell which was the larger, the water that was boiling in the kettle, or the steam that came out of the kettle?

CHILD.—Why, mother, the steam kept coming out of the tea-kettle all the time, and it had almost filled the room in a minute.

MOTHER.—But it was all made out of the water in the tea-kettle; was it not?

CHILD.—Yes, mother; but when it came out of the tea-kettle, there appeared to be enough in the room to fill a great many kettles.

MOTHER.—Then the steam was much larger than the water, was it not?

CHILD.—Oh, yes, mother; it was a great deal larger.

MOTHER.—What made it larger?

CHILD.—I am sure I do not know, mother.

MOTHER.—Then I will tell you, my dear, that it was the heat. The heat caused it to swell out and grow so large that it could not remain in the kettle. You see, then, that another of the effects of heat is, that it makes things grow larger. When Alice puts her little cakes into the oven to bake, you know they are very small, and do not fill the mould. When they are baked and taken out of the oven, you see that they have risen above the tops of the mould, and sometimes they run over the mould. Can you tell me the reason of this, Caroline?

CHILD.—Oh, yes, mother; the heat of the oven makes them swell out and grow larger. Is it not so?

MOTHER.—Yes, it is.

CHILD.—But, mother, what is the reason that when the cakes grow cold they do not grow smaller, in the same manner that the steam, when it grows cold, becomes smaller, and turns into water.

MOTHER.—Before the cakes were put into the oven, or, in other words, before heat was applied to them, they



were nothing but dough, or sponge. But after they are baked and have become cold, they do not change back again into dough, do they?

CHILD.—Why, no, dear mother.

MOTHER.—But what prevents them from turning back again to dough, my dear, when they are cold, in the same manner that the steam, when cold, turns back again to water?

CHILD.—Heat must have done something else to the cakes, besides causing them to swell, which prevents their turning back into dough, when they are cold.

MOTHER.—You are right; and the heat cooks our food also for us, and dries our clothes, and ripens the fruits in summer, and melts the cold snow and ice in winter, and forms the clouds which give us the refreshing showers in summer; so that heat must be mentioned with light, as one of the rich blessings which our Great Creator has bestowed upon us.

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#### QUESTIONS TO CONVERSATION SEVENTH.

Is fire and heat the same thing?

Can there be heat without fire, or fire without heat?

Does everything contain heat?

When the heat is taken away from water, what does the water become?



What effect does heat produce on water?

What does ice become, when put into a warm place?

What makes ice become water?

When ice is converted into water by heat, what will the water become, if more heat is applied?

When water boils away, where does it go?

What is cold?

What is heat?

What is heat like, in many things?

When heat is thrown against a bright surface, what becomes of it?

Has heat colors, like light?

Of what color is a coal fire?

What does the color of burning coal show?

Which is the more powerful, heat or light?

What effect does heat have on butter?

What does heat do to the wood and coal on a fire?

What do we mean when we say a thing *burns up*?

What remains when anything is burnt up?

What is ashes?

What else does heat produce from things that are burnt up, besides ashes?

Why does smoke rise, and ashes fall?

Does heat make things appear larger, or smaller?

What is the reason that cakes are larger after they have been baked?

What does heat do for us?

## CONVERSATION VIII.

## HEAT—CONTINUED.

CHILD.—You told me, mother, when we were talking about heat, that it is reflected, like light, but without colors. Will you please to explain this to me.

MOTHER.—Yes, my dear, heat is reflected, just in the same manner that light is, from all smooth surfaces. Now, you know what I meant when I told you that light is absorbed.

CHILD.—Oh yes, mother; I recollect that when we were talking about light, you showed me the difference between *absorbing* and *reflecting*. When I threw my little ball against the door and it bounded back from the door, you told me that light did the same thing when it fell on smooth surfaces, just as if light was made of a very great number of little balls. And when I threw a little water from the tumbler at your handkerchief, and it soaked into the handkerchief, and did not bound back from the handkerchief, as my ball did from the door, you said that the water was absorbed; and that light is absorbed, in the same manner, by those things that do not reflect it. But, mother, is heat both reflected and absorbed too?

MOTHER.—Heat is reflected, my dear, from bright things, just as light is from smooth ones; and it is absorbed by other things, that do not reflect it.

CHILD.—But, mother, you told me that heat cannot be seen, and that it has no color; how, then, can it be seen that it is reflected, or absorbed; and how can we tell anything about it?

MOTHER.—It is very true, that we cannot see it, and that it has no color; but if you were to shut your eyes, and I were to lead you about the room, could you tell me when I carried you near the fire?

CHILD.—Why, yes, mother; I could feel it.



MOTHER.—Well, my dear, we can, in the same way, discover that heat is reflected, as I shall presently show

you. But first I wish you to hold the back of the shovel up to the fire a few minutes, at the same time that I hold up this bright sheet of tin. We will hold them both at the same distance, and the same length of time.

CHILD.—Why, mother, the back of the shovel has become so hot that I cannot bear to touch it.

MOTHER.—Now, feel of the sheet of tin

CHILD.—Why, mother, the tin is scarcely warm; and yet it has been quite as long and as close to the fire as the shovel.

MOTHER.—Yes, my child, but the tin is bright, and reflects the heat; and the shovel is dark, and does not reflect it, but absorbs the heat, and therefore becomes warm first. Now, the heat is reflected from the tin, as it comes from the fire; and I suppose you can understand why it is that Alice puts the meat which is to be roasted into a tin-kitchen?

CHILD.—Oh yes, mother; the back of the tin-kitchen is bright, and reflects the heat of the fire; and the heat falls on the back of the meat, which is away from the fire. But, mother, Alice often turns the meat in the tin-kitchen, as she says, to roast the back parts of it, and to let all the parts come round to the fire.

MOTHER.—Very well; but it would take a much

longer time to roast the meat, if the back were not partly cooked by the heat reflected from the back of the tin-kitchen.\*

CHILD.—But, mother, there is no tin sheet in the oven, to reflect the heat there.

MOTHER.—That is true ; and it is not necessary that there should be, because the oven is surrounded by the heat. The heat from the fire goes up all around the sides of the oven, and heats it all around ; but when anything is placed before the fire, the heat from the fire will strike only those parts which are towards the fire, unless something reflects it back.

CHILD.—How very surprising, dear mother, all these things are, which you have told me, about the rain, and the snow, and the hail, and the clouds, and the colors, and light, and heat !

MOTHER.—Yes, my child, “we are surrounded by mysteries, and are mysteries even to ourselves.” And now, Caroline, I wish to ask you a question, to see whether you have been thinking much of what we

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\* The apparatus called a Connecticut Baker is also constructed on the same principle. The slanting top of the Baker reflects the heat to the top and back of the articles enclosed, to be cooked, and thus saves the heat which would otherwise be lost, and performs the cooking much more expeditiously.



have been talking about. You were very much surprised when I at first told you that light came from your father, when you saw him through the window. Now, can you tell me, Caroline, whether he gives out heat, too, as well as light?

CHILD. — Father give out heat, mother! Why, that appears more strange than when you said that light came from him, and I asked you whether he was a lamp. You almost persuaded me, mother, that he was a lamp; and now you wish to persuade me that he is a fire too.

MOTHER. — No, Caroline, I do not wish you to think that your father is really a lamp, because he gives out, or rather reflects, the light; for, if he were, there would be nothing but lamps in the world. Everything on which light shines, and which will reflect it, gives out the light that it reflects; and, as you and I, and everybody, give out this reflected light, we might all be called lamps with as much propriety as your father. Neither are we all fires, although all of us give out heat, too, as well as light.

CHILD. — Why, mother, I do not understand you. What is it that you mean to say?

MOTHER. — I mean to say, my dear, that our heavenly Father has endowed us with the faculty of producing heat, to warm ourselves.

CHILD.—How can we do that, mother?

MOTHER.—You know, Caroline, that when you go to bed on a cold night, the bed and the sheets, at first, feel very cold; and that after you have lain in bed a short time, you begin to feel warm.

CHILD.—Yes, mother, but it is the blankets, and the bed and bed-clothes, that make us warm.

MOTHER.—That *keep* you warm, my dear; not that *make* you so.

CHILD.—If the bed-clothes do not make us warm, dear mother, what is the reason that people who lie cold in bed want more blankets and bed-clothes?

MOTHER.—It is to keep the heat *in* the bed; not to make it.

CHILD.—Why, mother, there is no heat in the bed-clothes, when we get in on a cold night. The bed and the clothes all feel very cold, and we are very cold ourselves.

MOTHER.—Where, then, does the heat come from, Caroline? It is not in the bed, nor the blankets, nor the other bed-clothes; for you say that they are all very cold themselves.

CHILD.—I am sure, mother, I cannot tell.

MOTHER.—I told you, my dear, that everything contains heat, but that the heat is hidden, until something

causes it to come out. You recollect, that when Alice lighted the fire, she first kindled the match ; and the match kindled the shavings ; and the shavings kindled the coal and wood ; and then a nice warm fire was produced. Now, our great and good Creator has provided us with the means of obtaining sufficient heat to warm ourselves, without a fire, when we grow cold. How this is done, it will be very difficult to explain to you, until you are much older. But you know that although your hands and your feet, and perhaps your cheeks, may become cold, that your flesh is always warm. You have seen the boys in the streets, on a cold day, put their hands into their pockets, to keep them warm. The pocket is warm, because it lies near the warm flesh of the body. When you get into a cold bed, the warmth of the body warms the bed, and the bed-clothes keep the warmth in, and in a short time the whole body becomes warm.

CHILD. — How is it, mother, that the blankets and the bed-clothes keep the heat in ? Does not the heat go through the blankets and the bed-clothes, and go off, just as the steam did from the tea-kettle.

MOTHER. — You recollect that I told you, when we were talking about light, that there are some things which the light passes through very easily, as the glass

in the window-sashes; and that there are some things which the light cannot pass through easily, as the paper which you held up to the window; and there are some things which light cannot pass through at all, as the board which was held up to the window. Now, heat, like light, passes through some things much more easily than it does through others; but there are few, if any, things which heat will not pass through at all. Heat passes easily through linen, and with more difficulty through cotton, and with still more difficulty through wool and fur.

CHILD. — O yes, mother; and that is the reason that the blankets keep the heat in the bed, and thus keep us warm. The heat from our bodies goes easily through the linen sheets; but when it comes to the blankets, it cannot pass through them so easily. But, mother, why do some people have two blankets on the bed, if one will keep the heat in? Grandfather almost always has two blankets, and sometimes three, on his bed.

MOTHER. — I told you, my dear, that there are few things, if any, that heat will not pass through. But it does pass through the blanket, although it passes through it slowly; and if it is difficult for the heat to pass through one blanket, it will be more difficult for it to pass through two or three.

CHILD.—But, mother, if the heat passes through the blanket, and through everything on the bed, why do we not grow cold in bed, instead of growing warmer? Now, sometimes, when I wake in the night, I am so very warm that I wish to have some of the bed-clothes removed.

MOTHER.—I told you, my dear, that our Great Creator has given to our bodies the faculty of producing heat, to keep the flesh warm; and as fast as the heat passes from the body to the bed-clothes, the body makes more heat, and thus keeps the flesh constantly warm. When the body makes warmth or heat faster than it is carried through the bed-clothes, then the flesh becomes too warm, and we feel uncomfortable.

CHILD.—But, mother, what is the reason that grandfather has so many blankets on his bed? You seldom have more than one put on mine; and I am sure that I never saw more than two on yours.

MOTHER.—Can you tell me, my dear, why your grandfather cannot run, and dance, and skip about, as easily and as gayly as you do?

CHILD.—Why, grandfather is old, dear mother, and old folks cannot run so easily as young ones do.

MOTHER.—Yes; and that is the reason that he requires so many blankets to keep him warm. When



he was young, like you, he could move as quickly and as easily as you do. But now, age has impaired his sight; he cannot hear so well as he once did, and his body has lost a part of its power to produce heat to warm his flesh. He therefore needs more bed-clothes, to prevent the heat escaping.



CHILD.—You told me, mother, that the bed-clothes keep the heat of the flesh in the bed, and keep us warm. The other day, I saw Alice take the ice from the ice-man, and wrap it in a piece of blanket, before she put it into the refrigerator. Did she do that to keep the ice warm, mother, and to make it melt sooner?

MOTHER.—No, my child; she did that to keep the ice cold, and to prevent its melting.

CHILD.—Dear mother, will a blanket keep us warm, and keep the ice cold too? How very strange!

MOTHER.—No, my child, not strange at all. It keeps us warm, by keeping the heat in the bed where we lie. Now, you know, my dear, that when I lock the door, to keep us in the room, the door not only keeps us in, but it also keeps others out. If heat, then, is kept in the bed, because it cannot pass through the blanket, it will be kept away from the ice by the blanket which covers it. The ice, therefore, will melt much more slowly when it is covered by the blanket, for the blanket keeps the heat of the room away from it.

CHILD.—How many interesting things, dear mother, you have told me, about the rain, and the clouds, and the light, and beautiful colors, and heat! I wish you could tell me a little more about fire.

MOTHER.—I can tell you many things about it, when you are older, and are better able to understand them. But I have not quite done with heat. You saw that heat changed the wood and the coal into ashes, and smoke, and vapors; and you know that heat changes ice into water, and water into steam. You know that heat, when applied in sufficient quantity, appears to consume the wood and the coal. There are very few things, if any, that heat does not alter. When it is

applied in large quantities at a time, we see its effects almost immediately. Sometimes, when it is applied very slowly and for a long time, it produces changes much more remarkable. You have seen a hen sitting on eggs. The heat from her body warms the eggs, and in a few weeks the little chicken comes from the



shell. How this is produced, the Great Creator alone knows. But that it is done through the agency of heat, is well known, because some people have caused chickens to be hatched merely by keeping the eggs in a warm oven.

CHILD.—Why, mother, I thought the oven would cook the eggs!

MOTHER.—So it would, Caroline, if there were sufficient heat in the oven. But, to hatch the eggs, requires a constant heat, just as great as that of the body of the hen. It requires a greater degree of heat to cook the eggs; but if there be too much heat in the oven, the eggs will be burnt.

CHILD.—Mother, where does all the heat go to, that comes from the fire, and that escapes through the bed-clothes, and that comes from the sunshine, and other things.

MOTHER.—You have asked me now, my dear, a question that is very easy for me to answer; but I fear that you will find it more difficult to understand. Now, let me first ask you a simpler question, in order that it may assist you in understanding this. Suppose I should give you a large piece of cake, and tell you to go out into the street and give a piece to everybody that you meet, and that everybody who received a piece from you did the same with his piece, — that is, should give a small piece to every one that he meets, — what would become of the cake?

CHILD.—Why, mother, everybody would get a piece of it; but no one could keep any of it long, for he would



have to keep giving it away, as long as a crumb of it remains.

MOTHER.—Precisely so, my dear; and that is exactly what takes place with the heat. When the *hidden* heat becomes free, it diffuses itself equally all over the room; heating those things first which are nearest, and gradually extending itself all over the room; so that all things in the room become of the same warmth.

CHILD.—Why, dear mother, how can you say so? That beautiful smooth marble slab, on the centre-table, which you told me to draw my hand over, when we were talking about light,—it was so cold that I could scarcely bear my hand upon it.

MOTHER.—That *it felt* cold to your hand, my dear, I do not doubt; and perhaps I shall find some difficulty in convincing you that it was, in reality, as warm as any part of the table on which it stood. But before I attempt to explain this, I wish you to request Alice to fetch a small piece of ice from the refrigerator, in a plate, and also a basin of cold water.





CHILD. — I have done so, dear mother; and here comes Alice, with the ice and the water.

MOTHER. — Now take your left hand, Caroline, and plunge it into the basin of cold water, and tell me whether it feels cold to your hand.

CHILD. — Yes, dear mother; it feels very cold.

MOTHER. — Now take the ice in your right hand, and hold it a little while; and then return the ice to the plate, and put your right hand into the water, and tell me how the water feels.

CHILD. — Why, dear mother, the cold water in the basin feels quite warm to my right hand, although it felt so cold to the left.

MOTHER. — Exactly so; and you now see that the same thing may appear both warm and cold. It appears warm to that which is colder, and cold to that which is warmer. I told you that heat passes readily through some bodies, and with great difficulty through others. Those bodies which allow it to pass through them readily receive it quickly, and part with it quickly, and are therefore good conductors of heat; while those bodies through which it passes with difficulty receive it slowly, and part with it slowly, and are therefore bad conductors of heat. Now, your hand receives most of its heat from the warmth of your body.

When you touched the marble slab, the slab received the heat from your hand very quickly; and your hand felt cold, because the marble slab had taken so much of its heat. Whatever your hand touches, it communicates its heat to it. If the thing which it touches receives the heat quickly, that thing will appear cold to the hand; but if it receives the heat slowly, the hand does not perceive the loss of its heat.

CHILD.—But is not the marble slab colder than my hand, mother?

MOTHER.—Yes, Caroline: because the slab, like everything else in the room, receives its heat from the heat of the room. Your hand is warmer than the chairs, tables, and other furniture in the room, because it is constantly receiving heat from the body. But the slab is really no colder than anything around it. The reason that it feels cold is, that it receives the heat from your hand more readily than the other articles in the room; and your hand perceives the loss of heat, and of course feels cold. You recollect that I told you that cold is merely the absence of heat, just as darkness is merely the absence of light.

CHILD.—O yes, dear mother; how wonderful it all is!

MOTHER.—It is, indeed. Can you now tell me why it is that on a warm day your shoes feel tight,

and your feet uncomfortable, and you wish to take off your shoes?

CHILD.—I do not know, mother, unless it is because my shoes are too small.

MOTHER.—But they were large enough when you first put them on, in the morning, were they not?

CHILD.—Yes, dear mother; but I suppose that my feet have swollen, and therefore my shoes become too small.

MOTHER.—But what has caused your feet to swell, Caroline?

CHILD.—I am sure I do not know, mother; but I have heard a great many people say, in warm weather, that their feet have swollen.

MOTHER.—This is one of the effects of heat, my child. Heat, as I believe I have told you, makes almost everything grow larger; therefore, as the feet swell in hot weather, the shoes pinch the feet, unless they are made large enough to allow the feet to swell without crowding them.

CHILD.—Yes, mother; and when a person has a tight shoe, it will be better for that person to keep his feet away from the fire, lest the heat of the fire should make his feet swell more, and thus make the shoe still more uncomfortable.

MOTHER.— That is true; and you now begin, I hope, to see, that, while you are learning the reasons of the appearances around you, you are, at the same time, receiving useful practical lessons.

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QUESTIONS TO CONVERSATION EIGHTH.

How is heat reflected?

What is meant by *heat being absorbed*?

Is heat both reflected and absorbed?

How can we tell when heat is reflected?

Why does not anything bright become warm, when placed before a fire?

Of what use is "*a tin-kitchen*"?

Of what use are blankets and bed-clothes?

Where does the warmth that we feel in bed come from?

How are the hands warmed, when we put them into our pockets?

Does heat pass easily through all things?

Why do old persons require more bed-clothes than young ones?

Why is ice kept in woollen, in the summer season?

Where does heat go, when it escapes?

Why does a marble slab feel colder than a table-cloth?

What bodies are good conductors of heat?

What things feel cold to the touch?

Why do your shoes feel tight on a warm day?

What causes the feet to swell?

What effect does heat produce on almost everything?

Why should a person with a tight shoe keep his feet away from the fire?



## CONVERSATION IX.

## WIND.

CHILD.—Mother, you have told me so many wonderful things about the clouds, and rain, and other interesting subjects, that I almost forgot that we were *playing school* together. I want you now to tell me *what Wind is?*

MOTHER.—I must answer your question, Caroline, by asking another, first. Can you tell me what *air* is?



CHILD.—Air, mother, I have often heard you say, is *what we breathe*.

MOTHER.—Suppose, when you asked me what light is, I had told you it is *what we see*; should you have understood me, had I told you nothing else about it? And when you asked me what heat is, if I had told you that heat is what we feel when we go near to a fire, would that answer have made you understand anything more about it than you knew before you asked me?

CHILD.—Why, no, mother; certainly not.

MOTHER.—Then, when I ask you what air is, and you tell me that *it is what we breathe*, does that answer convey to your mind, or mine, any clear idea of what air is?

CHILD.—I cannot say, mother, that I think it does.

MOTHER.—Then you must try again.

CHILD.—The air, mother, is what comes in at the doors and the windows.

MOTHER.—And do not light and heat come in at the doors and windows?

CHILD.—Why, yes, mother; but I do not know what else to say about air.

MOTHER.—Do you know what fishes live and swim in?

CHILD.—They live, dear mother, and swim, in the water.

MOTHER.—And we also, like the fishes, live and move in something that in many respects resembles water.

CHILD.—What is that something, mother, resembling water, which we live in, as the fishes live in water?

MOTHER.—Air, my dear. It surrounds us, as the water surrounds the fishes.

CHILD.—But, mother, I can see the water which fishes live in, but I cannot see the air which you say we live in.

MOTHER.—No, my dear; neither can you see heat; but, nevertheless, you know that it exists, because you can feel it. Now, although we cannot see air, yet we can both feel it and hear it.

CHILD.—I am sure, dear mother, that I have never felt the air, nor heard it.

MOTHER.—And I am equally sure that you have both felt it and heard it, but did not know what it was.

CHILD.—When, dear mother, and where, have I heard it, or felt it?

MOTHER.—Every day, my child and almost all day long.

CHILD.—Dear mother, how you surprise me!

MOTHER.—It is no less true, Caroline, than surprising, as I shall presently show you. Have you never heard your little brother snapping his whip?

CHILD.—O, yes, dear mother, very often; and when father first gave it to him, he was snapping it almost all the time.

MOTHER.—And you have heard him blowing his whistle, too, have you not?

CHILD.—Why, yes, mother; and he sometimes makes such a noise with it, that I almost wish he never had had it.

MOTHER.—Did you ever think what it was that made the noise?

CHILD.—Why, it was the whistle, mother, was it not?

MOTHER.—Did you ever hear the whistle, when it was lying in the drawer, or on the table, or on the floor?

CHILD.—Why, no, mother; whistles do not whistle themselves, do they?

MOTHER.—No, of course they do not. When your little brother makes such a noise with it, how does he make the noise?



CHILD.—Why, mother, he only blows into the whistle, and then it makes the noise.

MOTHER.—But what does he blow into it, my dear?

CHILD.—Why, he blows his breath into it, mother; and that makes it make a noise.

MOTHER.—Come here, my dear, and let me *breathe* on your hand, and tell me whether you feel anything.

CHILD.—I only feel it a little warm, mother.

MOTHER.—And now I will *blow* on your hand, my dear. Tell me whether that feels warm, too.

CHILD.—No, dear mother; that feels quite cool.

MOTHER.—Then, Caroline, there is something that comes from your mouth, when you breathe, that is sometimes warm and sometimes cool.

CHILD.—Yes, dear mother, what is it? I cannot see it, any more than I can see heat. I thought it was heat, until you showed me that it is sometimes warm and sometimes cool.

MOTHER.—That something that comes from your mouth when you breathe, and is sometimes warm and sometimes cool, is the same thing that your little brother blows into his whistle, to make the noise. It is air.

CHILD.—Mother dear, I thought that the air was up in the skies, where the birds fly.

MOTHER. — So it is, Caroline ; and it is also down low, where pussy lies, and on the table, and in the chimney, and on the top of the house, and down in the cellar, and everywhere around us.

CHILD. — But, mother, I did not know the air is anything. If the air is anything, how can the birds fly in it?

MOTHER. — The water is something, you very well know ; and yet the fishes swim in it. Indeed, if the air were not something, the birds could not fly in it, any more than the fishes can swim when they are taken out of the water.

CHILD. — But, mother, if the air is something, why can we not see it, or feel it, except when some one blows, as you did on my hand ?

MOTHER. — We cannot, indeed, see it ; but we can see that it reflects the light.

CHILD. — How, dear mother, can we see it reflecting the light ?

MOTHER. — Do you not recollect, that I told you why the sky appears blue ?

CHILD. — Yes, mother ; you said that the blue rays of light could not go through the air like the red ones, and were therefore reflected by the air to our eyes.

MOTHER. — Then the air must be something that stops the rays, and reflects them.



CHILD.—But, mother, you said that the air is all around us; why, then, do we not see it all around us, as well as in the sky, reflecting the rays of light?

MOTHER.—Because, my dear, there is so small a quantity around us, compared with what is in what you call the sky. But although we cannot see the air around us, we can feel it, and hear it, whenever we please.



CHILD.—How, dear mother?

MOTHER.—When you fan yourself, you feel it; do you not?

CHILD.—O yes, mother.

MOTHER.—And do you not hear it too?

CHILD.—Why, mother, is the noise that I hear when

I am fanning myself, and which sounds so much like wind, made by air?

MOTHER.—Certainly it is; and the *wind* itself is nothing more than the *air put into motion*.

CHILD.—What puts it in motion, mother?—are so many people fanning themselves at the same time, as to make the wind blow so loud as we sometimes hear it?

MOTHER.—No, my dear; there are many causes which make the air move. We do not move ourselves, without making the air move too. Nay, we cannot lift our hand nor move a finger, without making the air move.

CHILD.—What, mother! do we make all the air in the sky, and all around us, move when we move?

MOTHER.—Not exactly so, my dear. In order that you may understand this better, I must show you something about water first. Take a tumbler, my dear, and fill it full of water, and set it on a salver, and bring it to me.

CHILD.—Here it is, mother; and it is so full that I feared I should spill it.

MOTHER.—Now, Caroline, put your hand into the tumbler of water, quite to the bottom of the tumbler.

CHILD.—The water has run out, all over the salver.

MOTHER.—That is precisely what I expected, my dear, and what I wished you particularly to notice. Now, can you tell me why the water ran over?

CHILD.—Why, mother, the water ran over because the tumbler was full, and there was not room in the tumbler for both my hand and the water too.

MOTHER.—You see, then, my dear, that two things cannot be in the same place at the same time. If we wish to put one thing where another thing is, we must first move that other thing.



CHILD.—But, mother, air does not require to be moved, does it, before we can put anything into the place where the air is?

MOTHER.—Just as much as water does, as I shall presently show you. Take this small phial, and put it into the water, holding it under the water until it is full, and tell me whether you can see the air come out.

CHILD.—No, mother, I do not see any air come out; I only see some bubbles coming up from the phial.

MOTHER.—Those things which you call bubbles, my

dear, are nothing but portions of air coming out of the phial, as the water gets into it, in the same manner that the water ran over the tumbler, to make room for your hand.

CHILD.—But, mother, you told me that we could not move a finger without moving the air too.

MOTHER.—That is true; the air surrounds us on all sides; and whenever we move, the air which is in the place where we move to moves out of our way, and goes to the place where we moved from. You see, then, that whenever anything is moved, the air must move out of the way, so as to make room and go into the place which was occupied by the thing that was moved.

CHILD.—And is that what makes wind, mother?

MOTHER.—No, it is not; there are other causes which produce wind. I told you, when we were talking about heat, that it made most things grow larger, or swell out, and occupy more space. I showed you that heat caused water to turn into steam, and grow much larger than it was when it was water. Heat produces the same effect upon air. It makes it swell out, and occupy more space.

CHILD.—Dear mother, can air be made to grow larger?



MOTHER. — Yes, my child, and smaller too. Do you know how your cousin George fills his foot-ball?

CHILD. — Yes, mother; I have seen him blow through a quill into the bladder, and fill it full, and then tie up the bladder tight and crowd it into its case, and then lace up the case tight.

MOTHER. — Here is a bladder, just like the one your cousin George has in his foot-ball. ' You see that it is not full, and that it is tied up tight, so that no more air can get in or out. Take it, my dear, and hold it near the fire, and you will see what effect the heat from the fire has upon the air in the bladder.

CHILD. — Why, mother, the air in the bladder has swelled so much that it has filled the bladder quite full.

MOTHER. — Now, take it, Caroline, and put it out of the window a few minutes, and then bring it to me.

CHILD. — I have done so, mother, and the bladder does not look so full as it appeared before I held it to the fire.

MOTHER. — No, my child, because the cold air has made it shrink, or grow smaller. You see, then, that the air can be made to swell out and grow larger by heat, and to shrink, or grow smaller, when it is cold. Now, this is the cause which produces wind. The sun shines very powerfully in some places all the time, and makes it very hot; and thus the air gets heated and



swells out; and then, when it grows cold again, it shrinks; and this makes the air keep swelling and shrinking, and produces that motion of air which we call wind.

CHILD.—You told me, mother, that no two things can be in the same place at the same time. Now, when I put the tumbler into a pail, or basin of water, what is the reason that the air does not come out of the tumbler before the water goes in?

MOTHER.—It does, my dear; and we cannot put water into any vessel which we call empty, until the air has had an opportunity to come out.

CHILD.—But I do not see any bubbles, mother, when I fill the tumbler of water from the pail.

MOTHER.—No, of course you do not, because the water rushes in all at once, and fills the tumbler, and you see no bubble and hear no sound, unless the tumbler gets below the surface of the water before it is filled. Now, Caroline, take the tumbler, and having turned it upside down, put it down into the water upside down.

CHILD.—The water does not go into the tumbler at all, mother.

MOTHER.—How can it, my dear? there is no way for the air to get out of the tumbler, and the water cannot

go into the tumbler until the air has come out. You recollect that I told you that those things which are lighter than water will always ascend in water; and therefore the air must go upwards, because it is lighter than water; and when it goes upwards, it cannot get out of the tumbler, because while the bottom of the tumbler is uppermost, it prevents the air from coming up.

CHILD. — But, mother, how did the air get out of the phial when it was under the water, so that the water might get into the phial?

MOTHER. — It came out of the mouth of the phial; for, if you recollect, you put the phial into the water with the mouth uppermost. Now empty the phial, and put it into the water upside down.

CHILD. — Why, look, mother! when I put the phial into the water upside down, the water will not go into the phial at all, any more than it did into the tumbler.

MOTHER. — Of course it will not; and I suppose that you now understand the reason why.

CHILD. — Oh, yes, mother; there is no way for the air to come out of the phial, unless it can go down and out of the mouth of the phial; and you told me that air could not go down in the water, because it is lighter than water.

MOTHER. — You are right, my dear; but I have not

yet told you all that I intended to, show you, to convince you that nothing can occupy the place where air is, until the air is first removed.

I am going to let the air all out of the bladder, and then you shall see me fill it with air, and tie it up tight.

And now, Caroline, that I have done it, you may take the bladder and squeeze the sides together.

CHILD. — I cannot do it, mother; there is something hard now inside of the bladder, so that I can squeeze it but a little; and as soon as I have done squeezing it, it swells out again, as plump as it was before.

MOTHER. — There was nothing in it, my child, but air, and you saw me put it in.

CHILD. — But, mother, if there was nothing in the bladder but air, that seemed so hard, why does not the air around me feel hard too?

MOTHER. — Because the air around you is not confined, my dear, and when you press it it gets out of your way. Now, the air in the bladder was confined, and could not get out of the bladder, and therefore felt hard. But I will now untie the bladder, and you may then try to press the sides together.

CHILD. — Why, mother, I can press the sides of the bladder together very easily now; but the air has all gone out of the bladder.

MOTHER.—Yes, my dear; and now I wish you to take a pitcher, and pour some water from the pitcher quickly into the phial.

CHILD.—It will not go into the phial, mother; it has run all over the sides of the phial, but there is scarcely a drop of the water in the phial.

MOTHER.—No, Caroline; you poured the water so fast that it stopped up the mouth of the phial, and prevented the air from coming out; and, of course, the water could not go in, while the air was there.

CHILD.—I think I understand it now, dear mother; and now that you have explained it to me, it appears so simple, and easy to understand, that I am almost surprised that I did not find it out myself.

MOTHER.—All things appear simple, and easy to understand, my dear, after we have found them out.

But our great and good Creator has seen fit to surround us with objects that we do not at first understand, in order that we may have an agreeable occupation in endeavoring to find them out. He has given us beautiful fields, capable of producing fruits, and flowers, and vegetables, for our use; but he has left the labor of tilling the ground and sowing the seeds to us. He has furnished us with the means of clothing ourselves, and given us the materials to build beautiful houses to

protect us from the weather; but he has not made our clothes, nor built our houses for us. He has placed his wonders all around us, but he has not explained them to us himself. But he has kindly given us powers by which we can readily supply all that he has wisely left undone, and we are thus enabled to look through Nature up to Nature's God; and truly may we say:

“Happy the man who sees a God employed  
In all the good and ill that chequer life.”

CHILD.—Mother, I have only one more hard question to ask you now. You have been very kind to me, to explain so many things to me, so that I can now understand them. But when you were talking about my little brother's whip and whistle, you told me that it was the air that made the noise. Now, mother, what is the reason that light and heat, when they move, do not make a noise, as well as air?

MOTHER.—I will answer your question by asking another. You hear the sound, but do not *see* it. You see the light, and feel the heat, but do not *hear* it. What is the reason that we do not *hear* the light as well as *see* it, and why do we not *see* the heat as well as *feel* it?

CHILD.—Why, mother, those are very hard questions, and I am sure that I cannot answer them.



MOTHER.—I presume not, my dear, and I did not expect that you could. Can you tell me why you do not walk on your hands, stand on your head, and feed yourself with your feet?

CHILD.—Dear mother, what strange questions those are!

MOTHER.—Not more strange, my dear, than the question, why we do not see a sound. It has pleased our great Creator to give us certain organs, faculties, and powers, for particular purposes, and for them alone. He placed us on our feet, that we might stand firmly; enabled us to walk with our lower limbs, and designed that we should use our hands to feed ourselves, and to serve the other organs. He has given us also particular faculties, called *the senses*, by which we are enabled to *see, hear, smell, and taste*. The eyes are used for seeing, and for seeing alone. The ear, for hearing; the nose, for smelling; the mouth, for tasting; while the whole body is endowed with the sense of feeling.

Now, there are some things which are the objects of all these senses. For instance, when you are enjoying your cake, you can *see it, feel it, smell it, and taste it*; and you can also hear the sound you make in biting and chewing it. You see, then, Caroline, that each sense affords you both knowledge and enjoyment.

You know some of the objects around you by *seeing* them; others by *hearing* them; others again by *feeling* them, and again others by *smelling* and *tasting* them: and thus you can be made to understand, partly at least, what the Bible tells you in the book of Psalms, where it says that we are fearfully and *wonderfully* made. How good, then, must that great Being be, who made us, and gave us all the blessings that we enjoy, and the means of enjoying them !

When you are older, my dear, you will be able to understand more of the meaning of that sentence which I have just repeated from the book of Psalms. You will then understand what is meant by the expression that God made man in his own image. You will see that your body is but one part of that being which you call yourself. That you have a more noble nature, called the *Intellectual*, by which you are enabled to think, to reason, to compare, and to judge. And finally, you will learn more of yourself, and discover that there is still a nobler part of you, called your *Spiritual* being, which will live long after everything else has died away, and which cannot be satisfied with the things of this world. but aspires to the happiness of a future state, where you shall see God as he is, and know even as you are known.

## QUESTIONS TO CONVERSATION NINTH.

What do fishes live and swim in? *WATER*

What do we live and breathe in? *AIR*

Can you see the air? *NO*

How do you know that there is such a thing as air, if you cannot see it? *FEELING*

What makes the noise from a whistle? *WIND*

Where is the air? *AIR*

What makes the noise heard in fanning one's self?

What is wind?

What puts the air in motion, to cause wind?

When you put anything into a vessel full of water, why does the water run out?

Can two things occupy the same place at the same time?

What are the bubbles that come from an empty bottle, when it is first put under water?

When anything is moved, what becomes of the air that was in the place to which it was moved?

What effect does heat have upon air?

What effect has cold on air?

What produces that *motion of the air* which we call *wind*?

Why will not the water go into a bottle or a tumbler placed upside down in the water?

Why will not the air come out of the tumbler, when it is upside down?

Why can you not pour water fast into an empty bottle?

What is the reason that light and heat cannot be *heard*, as well as air?

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Chapman's Elements of Geometry.  
Clark's Elements of Geometry.  
Chapman's New Geometry.  
Redd and Bain's Geometry.  
Hamilton's Vector and Quaternion.  
Chapman's Elements of Geometry.  
Pige's Elements of Geometry.

Willard's History of the United States.  
Willard's Science, History of the United States.  
Willard's Curve and History of the United States.  
Willard's American Geography.  
Willard's Temple of Time.  
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Northrup's Little, p. 10.  
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Watts on the Mind. (With Questions.)  
Dutton's Ancient Classical Grammar.  
Knapp's Ancient Chorus.  
Knapp's Young Ladies' Grammar.  
Knapp's Grammar.  
Knapp's Poetical Grammar.  
School Song and History Book.  
Minsell's Grammar.  
Page's Theory of Grammar.  
Parnall's Grammar.  
Homer's Iliad.  
Polytechnic New Grammar.